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NEW HAVEN, CONN.

Bulletin 203

BEING THE

SEVENTEENTH REPORT OF THE STATE ENTOMOLOGIST FOR 1917

W. E. BRITTON, PH.D.

SEVENTEENTH REPORT

OF THE

STATE ENTOMOLOGIST

OF

CONNECTICUT

FOR THE YEAR 1917

(Being Bulletin 203, Connecticut Agricultural Experiment Station)

BY

W. E. BRITTON, PH.D.

State Entomologist

NEW HAVEN, CONN.

1918

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Vegetable Growing.	W. C. PELTON, B.S.

* Died January 10, 1918.
† Absent on leave, In U. S. Service.

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BULLETIN 203

SEVENTEENTH REPORT

OF THE

State Entomologist of Connecticut

To the Director and Board of Control of the Connecticut Agricultural Experiment Station:

I have the honor to submit the following pages as my seventeenth report as State Entomologist of Connecticut for the fiscal year ending September 30, 1917. This report contains brief accounts of the various lines of inspection and control work placed under the State Entomologist by legislative enactment; the chief entomological features of the season; and several special articles dealing with injurious insects which embody the results of study and observation by members of the staff.

Respectfully submitted,
W. E. Britton,
State Entomologist.

REPORT OF THE RECEIPTS AND EXPENDITURES OF THE STATE ENTOMOLOGIST FROM OCTOBER 1ST, 1916, TO SEPTEMBER 30TH, 1917.

RECEIPTS.

From E. H. Jenkins, Treasurer	$4,000.00	
Account of 1916, Balance	974.10	
State Comptroller, Apiary Inspection Account	10.50	
" " Gipsy Moth Control Account	434.00	
		$5,418.60

EXPENDITURES.

For Field, Office and Laboratory Assistance:		
B. H. Walden, salary	$875.00	
Q. S. Lowry, "	1,141.62	
M. P. Zappe, "	1,083.31	
J. S. Miller, "	72.00	
J. K. Lewis, "	21.00	
Alice C. Heath, "	277.42	
Grace A. Foote, "	397.75	
Other stenographic work	2.00	
		$3,870.10

EXPENDITURES (*Continued.*)	$3,870.10	
Printing and Illustrations	14.10	
Postage	56.82	
Stationery	16.78	
Telegraph and Telephone	9.54	
Office Supplies	102.20	
Library	40.43	
Laboratory Supplies	49.74	
Express, Freight and Cartage	3.45	
Tools and Supplies	83.68	
Travelling Expenses	185.05	
Balance, cash on hand	986.71	
		$5,418.60

Memorandum:—This account of the State Entomologist has been audited by the State Auditors of Public Accounts. The items of $10.50 and $434.00 credited above as received from the State Comptroller are transfers from other appropriations to cover time expended on work for which such appropriations were made.

SUMMARY OF INSPECTION AND OFFICE WORK.

325 samples of insects received for identification.
86 nurseries inspected.
86 regular certificates granted.
40 parcels of nursery stock inspected and certified.
49 orchards and gardens examined.
163 shipments, containing 682 cases, 1,706,977 plants imported nursery stock inspected.
45 shipments, or 28 per cent. found infested with insects or fungi.
473 apiaries, containing 4,506 colonies, inspected.
79 apiaries, containing 219 colonies, found infested with European foul brood.
2 apiaries, containing 8 colonies, found infested with American foul brood.
7 apiaries, containing 9 colonies, found infested with pickled or sac-brood.
2026 letters written on official work.
435 post cards written on official work.
171 reports of inspection to Federal Horticultural Board.
890 bulletins, etc., mailed on request or to answer inquiries.
84 packages sent by mail or express.
30 lectures and addresses made at institutes, granges, etc.

PUBLICATIONS OF ENTOMOLOGICAL DEPARTMENT, 1917.

By W. E. Britton:

Sixteenth Report of the State Entomologist (Part II of Station Report for 1916); 82 pages, 3 figures, xvi plates; 10,000 copies distributed in April.

Report of Committee on Injurious Insects, Proceedings Connecticut Pomological Society, page 20. (3½ pages) 1917.

Report of Committee on Injurious Insects, Proceedings Connecticut Vegetable Growers' Association, page 17 (2 pages) 1917.

Recent Anti-Mosquito Work in Connecticut (2 pages), Journal of Economic Entomology, Vol. 10, page 109, 1917.

Bulletin 195, Insects Injuring Stored Food Products in Connecticut, 21 pages, 18 figures; 10,500 copies distributed in August.

Mosquito Control Work in Connecticut in 1916. Proceedings Fourth Annual Meeting of the New Jersey Mosquito Extermination Association, page 184 (6 pages) 1917.

By B. H. Walden:

Simple Apparatus for Insect Photography. (6 pages, 1 plate) Journal of Economic Entomology, Vol. 10, page 25, 1917.

By Quincy S. Lowry:

An Outbreak of the Eight-Spotted Forester, *Alypia octomaculata*, in New Haven, Conn. (2 pages) Journal of Economic Entomology, Vol 10, page 47, 1917.

By Irving W. Davis:

The Present Status of the Gipsy and Brown-Tail Moths in Connecticut, (2 pages) Journal of Economic Entomology, Vol. 10, page 193, 1917.

By M. P. Zappe:

Egg-Laying Habits of *Diprion simile* Hartig. (2 pages) Journal of Economic Entomology, Vol 10, page 188, 1917.

Department Staff

W. E. Britton, Ph.D. ..... *State and Station Entomologist.*
B. H. Walden, B.Agr. ..... *First Assistant.*
Quincy S. Lowry, B.Sc. ..... *Assistant.*
Max P. Zappe, B.S. ..... *Assistant.*
Irving W. Davis, B.Sc. ... *Assistant and Deputy in Charge of Moth Work.*
J. T. Ashworth ..... *Assistant in Moth Work.*
Miss Grace A. Foote, B.A. ..... *Clerk and Stenographer.*

H. W. Coley, Westport
A. W. Yates, Hartford } ..... *Apiary Inspectors.*

Messrs. Walden, Lowry, Davis and Zappe have continued as assistants and have all aided in the inspection of nursery stock, as well as in the general work of the department.

Mr. Walden was detailed as deputy to the Director of the Station to look after the mosquito drainage work under the new law,

and was thus occupied throughout the six summer months. Half of his yearly salary will now be paid from the insect pest appropriation and the other half from Station funds, or from the appropriation for mosquito control work. Mr. Walden spent most of his time in the field during the summer but was able to do some of the general photographic work of the department and helped inspect some of the nurseries.

Mr. Lowry has been engaged in the inspection of growing nursery stock, imported nursery stock, and has studied the insects attacking vegetable crops. He conducted experiments at the Station farm at Mt. Carmel in controlling the striped cucumber beetle and other insects attacking cucurbitaceous plants, but on account of an operation for appendicitis was obliged to be in the hospital for about six weeks in May and early June.

Mr. Davis has continued in charge of the work of suppressing the gipsy moth and the brown-tail moth, and has been located at Danielson throughout the year. He has inspected most of the nurseries and some of the imported nursery stock in the eastern portion of the State. On account of an operation, he was unable to aid in the general inspection of the larger nurseries as in former years.

Mr. J. T. Ashworth has been employed since June 1 as assistant to Mr. Davis. Mr. Ashworth also resides in Danielson.

Mr. Zappe has helped inspect nurseries and imported stock, has been in charge of the insectary, and has worked on the collections. He has also collaborated with the entomologist in studying the life history of the European pine sawfly, *Diprion simile*, and in some orchard spraying experiments for the control of the false apple red-bug. Mr. Zappe has also investigated and devised methods of controlling a southern cockroach, *Pycnoscelus surinamensis*, which has caused much damage in the greenhouses of A. N. Pierson, Inc., Cromwell, and the little red ant or Pharaoh's ant, *Monomorium pharaonis*, an annoying pest in a large dwelling house in Hartford.

Miss Foote has done the necessary stenographic and clerical work and has also indexed much literature to facilitate the looking up of references. She has also kept records and made out the reports to the Federal Horticultural Board. From November to April she was called home by sickness and the work was done by Miss Alice C. Heath.

Mr. J. Kirby Lewis was employed for a few days in August, and Mr. J. S. Miller for three weeks in September, to help inspect nurseries.

Messrs. H. W. Coley and A. W. Yates have made the apiary inspections as in preceding years on a *per diem* basis.

All mentioned above who have aided in the work of the department have labored conscientiously and their efforts are duly appreciated.

New Equipment.

No new equipment of importance has been obtained for the office or laboratory during the year. In the gipsy moth work, the Ford car was exchanged for a new one in the spring and a new "Buick four" was purchased early in the summer.

Chief Lines of Work.

As has been the case for several years, the required routine and control work continues to monopolize the time and efforts of the staff. This includes the annual systematic inspection of nurseries, and the inspection of orchards, fields, gardens and greenhouses on request. In co-operation with the Federal Horticultural Board all woody field-grown stock imported into Connecticut from foreign countries has been inspected.

The work of suppressing the gipsy and brown-tail moths is placed in charge of the State Entomologist. This work has been in immediate supervision of Mr. Davis, aided by Mr. Ashworth, though all expenses are paid upon the order of the State Comptroller, on duly receipted, certified and approved vouchers.

The inspection of apiaries is also placed by law upon the office of State Entomologist, though, like the gipsy moth work, the bills are paid from Hartford.

The department has been concerned with the anti-mosquito work, not only around New Haven, but also of the whole state. Mr. Walden has been in immediate charge.

Studies of the European pine sawfly, *Diprion simile*, have been continued and are now about finished and ready for publication.

Means for controlling a pest of cockroaches in greenhouses, and the little red ant or Pharaoh's ant in dwelling houses, have been worked out by Mr. Zappe.

Mr. Zappe and the Entomologist have conducted spraying experiments at Clintonville and at Milford to control apple aphids and apple red-bugs.

The study of insects attacking vegetable crops has been continued by Mr. Lowry, who has prepared the paper published in this report on the Striped Cucumber Beetle. Further work will be done on squash and cucumber insects.

Considerable time was put upon editing, indexing and reading proof of the "Hymenoptera of Connecticut," which was issued in March as Bulletin No. 22 of the Connecticut State Geological and Natural History Survey.

The Entomologist has also prepared, and later revised for publication, A Check List of The Insects of Connecticut, which will be published by the Survey. He has also written a portion, and edited the remainder, of a series of papers on the "Hemiptera of Connecticut," which will be published by the Survey at some time in the future.

The outbreak of the potato aphid was sudden, widespread, and caused much damage. On account of the war and the campaign to plant vegetable gardens in city back yards and on farms, the correspondence of the office, as well as telephone inquiries, required more than the usual attention.

The following pages of this report give in greater detail an account of the work of the department for the year.

INSPECTION OF NURSERIES.

Nursery inspection was commenced on August 6, and finished on October 15, and the work was done by Messrs. Lowry, Zappe, Davis, Walden, J. S. Miller, J. K. Lewis, G. A. Root and Britton. Mr. Root was employed for the summer by the State Forester in suppressing the white pine blister rust, and was detailed to examine the currant bushes and pine trees in the nurseries for this disease. Though it had been found in two nurseries previously, no signs of it occurred in any of them at the time of the annual inspection.

The Ford car was spared from the gipsy moth work from August 11 to October 5 and was used to transport the men. It was especially useful in reaching the larger nurseries and even others which are not adjacent to railroad and trolley lines.

All nurseries were given a thorough inspection, and on the whole were found to be in good condition. All infested trees and shrubs were marked and the owner was informed regarding them and directed to treat or destroy those having pests liable to be distributed on nursery stock.

In 29 nurseries no pests were found. The following pests were found in the number of nurseries indicated: Oyster-shell scale, 44; San Jose scale, 23; scurfy scale, 14; spruce gall aphid, 14; poplar canker, 9; tulip tree scale, 4; pine leaf scale, 3; lilac borer, 3; chestnut blight, 2; imported European pine sawfly, 2; elm scale, 2; *Lina scripta*, 2; pear leaf blister mite, 2; Oak leaf roller, 2; apple borer, ash borer, linden borer, shot hole borer, Abbott's sawfly, juniper web-worm, *Lina japonica*, peach leaf miner, *Lecanium*, pit-making oak scale, rose scale, and West Indian peach scale, 1 each.

Of course, such common insects as aphids, fall web-worm, white-marked tussock moth, *Datana ministra*, red-humped caterpillar and leaf hoppers were found almost everywhere, and are not taken into account except in severe infestations.

In addition to the regular inspections, a number of parcels have been examined and certified. These were to be shipped by persons not in the nursery business, or perhaps the stock was not covered by the regular certificates, and these parcels were refused by the transportation companies unless accompanied by certificates. During the year 40 such parcel certificates were issued.

Two nurseries were inspected twice, in addition to the examinations for pine blister rust, which were made in May and June in the several nurseries having pine trees.

Of the 83 names on the nurserymen's list for 1917, four are new since the publication of the last year's list. Two have dropped the nursery business, three firms have changed names, and two have not yet cleaned up their nurseries so as to receive certificates.

The area devoted to growing nursery stock in Connecticut is about the same as last year, being slightly curtailed on account of the scarcity of labor, and amounts to about 1,500 acres. The list for 1917, together with date and number of certificate, and acreage of each, is given below:

NURSERY FIRMS IN CONNECTICUT RECEIVING CERTIFICATES IN 1917.

Name of Firm	Address	Acreage	Certificate Issued	No. of Certificate
Alderson & Dell, The Misses	Greenwich	1	Sept. 29	842
Barnes Bros. Nursery Co.	Yalesville	155	Oct. 5	853
Beattie, Wm. H.	New Haven	1	Oct. 9	864
Bertolf Bros.	Sound Beach	25	Oct. 16	871
Bowditch, J. H.	Pomfret Center	8	Sept. 12	819
Bradley, H. M.	Derby	1	Dec. 18	895

NURSERY FIRMS IN CONNECTICUT RECEIVING CERTIFICATES IN 1917--*Con.*

Name of Firm	Address	Acreage	Certificate Issued	No. of Certificate
Bradley, Smith T.	New Haven	1	Nov. 22	887
Brainard Nursery & Seed Co.	Thompsonville	6	Oct. 3	850
Braley & Co.	Burnside	1	Sept. 26	833
Bretschneider, A.	Danielson	1	Sept. 5	813
Brooks Bros.	Westbrook	2	Oct. 11	867
Burr & Co., C. R.	Manchester	300	Sept. 15	822
Burroughs, Thos. E.	Deep River	3	Sept. 17	824
Chapman, C. B.	Groton	1	Oct. 1	844
Chapman, C. E.	North Stonington	2	Sept. 28	835
Conine Nursery Co., The F. E.	Stratford	50	Oct. 3	849
Conley, L. D.	Ridgefield	3	Sept. 25	830
Conn. Agricultural College (Prof. S. P. Hollister)	Storrs	2	Oct. 8	860
Conn. Agri. Experiment Station (W. O. Filley, State Forester)	New Haven	1	Sept. 25	832
Conway, W. B.	New Haven	1	Oct. 8	858
Crofut & Knapp Farm	Norwalk	60	Oct. 9	862
Cross Highway Nurseries	Westport	6	Nov. 23	889
Dallas, Inc., Alexander	Waterbury	3	Oct. 25	875
Dowd, Frank C.	Madison	3	Nov. 26	891
Elm City Nursery Co., Woodmont Nurseries, Inc.	Woodmont & New Haven	155	Sept. 15	823
Fairfield Landscape & Nurseries Co.	Cannon Station	5	Nov. 10	881
Gardner's Nurseries	Cromwell	10	Sept. 14	821
Geduldig, G., Estate of	Norwich	1	Oct. 2	847
Goodwin Associates, Inc., The James L.	Hartford	1	Sept. 25	828
Hartford Park Commissioners (G. A. Parker, Supt.)	Hartford	3	Sept. 28	837
Heath & Co., H. S.	Manchester	50	Sept. 7	817
Hilliard, H. J.	Sound View	1	Sept. 28	836
Holcomb, Irving	Simsbury	1	Sept. 12	818
Horan & Son, Jas.	Bridgeport	1	Oct. 3	851
Houston & Sons, J. R.	Mansfield	6	Oct. 8	861
Hoyt's Sons Co., The Stephen	New Canaan	300	Oct. 19	873
Hubbard & Co., Paul M.	Bristol	12	Oct. 20	874
Hunt & Co., W. W.	Hartford	12	Sept. 29	839
Intravaia, Joseph (2)	Middletown	1	Sept. 17	825
Isselee, Charles.	Darien	3	Oct. 3	852
Kelley, James	New Canaan	1	Sept. 7	814
Kellner, Herman H.	Danbury	1	Oct. 2	846
Long, J. A.	East Haven	1	Nov. 26	893
Mallett & Co., G. A.	Bridgeport	1	Nov. 10	882

NURSERY FIRMS IN CONNECTICUT RECEIVING CERTIFICATES IN 1917--*Con.*

Name of Firm	Address	Acreage	Certificate Issued	No. of Certificate
Maplewood Nurseries (T. A. Peabody, Mgr.)	Norwich	1	Oct. 2	848
Marigold Farm (H. Kelley, Prop.)	New Canaan	1	Sept. 7	815
McDermott, E. F.	Windsor	1	Sept. 25	829
Meier & Gillette	West Hartford	2	Nov. 26	892
Munro, Charles	New Haven	1	Sept. 29	841
New Haven Nurseries Co.	New Haven	10	Oct. 16	870
New Haven Park Commissioners (G. X. Amrhyn, Supt.)	New Haven	30	Nov. 12	883
New London Cemetery Association (F. S. Newcomb, Pres.)	New London	2	Oct. 1	845
North-Eastern Forestry Co.	Cheshire	20	Sept. 22	826
Norwich Nurseries (O. E. Ryther, Prop.) (2)	Norwich	6	Oct. 30	878
Oakland Nurseries	Manchester	50	Sept. 7	816
Palmer, L. M., Estate of	Stamford	5	Nov. 22	888
Park Gardens	Bridgeport	1	Nov. 7	879
Pequod Nursery Co.	Meriden	15	Oct. 5	855
Phelps, J. Wesson	Bolton	1	Sept. 29	843
Phelps & V. T. Hammer Co., The J. W	Branford	2	Oct. 11	866
Pierson, A. N., Inc.	Cromwell	45	Sept. 28	834
Platt Co., The Frank S.	New Haven	1	Nov. 12	884
Pomeroy, Edwin C.	Northville	1	Sept. 25	831
Purington, C. O.	Hartford	1	Sept. 25	827
Quality Seed Store	Stamford	1	Oct. 10	865
Raab, Joseph O.	Ansonia	1	Oct. 5	856
Reck, Julius	Bridgeport	1	Oct. 13	868
Roehrich, W. G.	Stratford	1	Oct. 15	869
Saxe & Floto	Waterbury	1	Nov. 23	890
Scott, J. W.	Hartford	5		
Sierman, C. H.	Hartford	3	Oct. 25	876
South Wilton Nurseries	South Wilton	5	Sept. 14	820
Steck, Charles A.	Bethel	1	Sept. 29	838
Stratfield Nursery Co.	Bridgeport	4	Nov. 9	880
Traendly & Schenck	Rowayton	2	Oct. 6	857
Upson, R. E.	Marion	3	Nov. 17	886
Verkade, H.	New London	1	Nov. 12	885
Vidbourne & Co., J.	Hartford	7	Sept. 29	840
Wallace, Arthur T.	Wallingford	1	Oct. 16	872
Wallingford Nurseries	Wallingford	10	Oct. 5	854
Wilson & Co., C. E.	Manchester	7	Sept. 5	812
Yale University Forest School	New Haven	2	Oct. 9	863
Young, Mrs. Nellie A.	Pine Orchard	1	Oct. 30	877
		1,461		

INSPECTION OF IMPORTED NURSERY STOCK.

On account of the war, fewer shipments, cases and plants were received than during 1916, as the following figures show:

Year	Shipments	Cases	Plants
1916	291	2,102	1,998,178
1917	163	682	1,706,977

These shipments have entered the country under the system of permits and notices adopted by the Federal Horticultural Board five years ago, and which is still in force.

Reports have been made to the Board of 171 shipments, 8 of which were not inspected; 3 were refused by consignee, 2 contained seeds, 2 herbaceous stock, and one was destroyed by consignee.

The stock came from about the same countries and in about the same proportions as in 1916, except that from Belgium a larger proportion of shipments was received. Most of the stock grown in Belgium was taken into Holland and shipped from Holland ports. The figures for these shipments are given in in the following table:

SOURCES OF IMPORTED NURSERY STOCK, 1916–1917.

Country	No. of Shipments	No. of Cases
Holland	57	249
Belgium	56	234
France	21	138
Ireland	12	14
England	9	32
Scotland	3	3
Japan	3	9
Ontario	1	2
Bermuda	1	1
Total	163	682

Most of this stock was inspected by Mr. Lowry, but Messrs. Zappe, Davis, Walden and Britton helped. The total time required in making these inspections amounts to 120 days of 7½ hours each, or about two-fifths of the working time of an entire year. The cost of this work, including time and travelling expenses, has amounted to about $663.00, or slightly more than half that of last year, and has been paid on duly accredited vouchers by order of the State Comptroller from the appropriation for suppressing gipsy and brown-tail moths and for inspecting imported nursery stock.

Of the 163 shipments inspected, 45 shipments, or about 28 per cent., were found infested with insects or fungi, some of which are pests. Among others, perhaps one of the most important discoveries was an egg-mass of the European lackey moth, *Malacosoma neustria* Linn., a defoliator of fruit trees, oak, elm, rose, poplar, hawthorn and hornbeam.* Had these eggs not been intercepted, they might have hatched and started a colony of the lackey moth in this country.

Some of the insects were identified here, and some of the fungi were determined by Dr. G. P. Clinton, Botanist of this Station. The other insects and fungi were identified by specialists in the Bureaus of Entomology and Plant Industry of the U. S. Department of Agriculture, Washington, D. C.

The information regarding these infestations occurs in the following list:

PLANT DISEASES AND INSECTS ON IMPORTED NURSERY STOCK, 1916–17.

45 Shipments infested.

Plant Diseases.

Exobasidium vaccinii on Azalea. (29 shipments.)
Bier & Ankersmit, Melle, Belgium; G. J. Bier, Nieuwerkerk, Holland; M. Debaerdemaeker, Everghem, Belgium (3); DeCoster Bros., Melle, Belgium; Achille de Coster, Melle, Belgium (2); Arthur de Meyer, Mont St. Amand, Ghent, Belgium (2); August de Vreese, Loochristy, Belgium (4); Guldemond & Son, Lisse, Holland; K. J. Kuyk, Ltd., Ghent, Belgium (4); Van Dillewyn & Thiel, Meirelbeke, Belgium (7); Van Gelderen & Co., Loochristy, Belgium (2); A. Van Schoote, Ghent, Belgium.

Pseudomonas tumifaciens Crown Gall.
On Pear. Franco-American Seedling Co., Ussy, France.
On Lilac. F. Delaunay, Angers, France.
On Rose. F. Delaunay, Angers, France; W. Fromow & Sons, Windlesham, Surrey, England; Vincent Lebreton's Nursery, La Pyramide-Trelaze, France.

Acremoniella atra (a saphrophyte) on Rhododendron. Hugo T. Hooftman, Boskoop, Holland.

Macrosporium sp. (a saphrophyte) on Rhododendron. Hugo T. Hooftman, Boskoop, Holland.

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* W. D. Pierce. A Manual of Dangerous Insects Likely to be Introduced in the United States through Importations. U. S. Dept. of Agr. p. 106, 1917.

Pestalozzia guepini on Rhododendron.
Harry Koolbergen, Boskoop, Holland; Schaum & Van Tol, Boskoop, Holland.
Phyllosticta sp. on Rhododendron. Harry Koolbergen, Boskoop, Holland.
Glomerella cingulata on Palm. K. J. Kuyk, Ltd., Ghent, Belgium (2).
Ascomycete on Oak, Immature. Franco-American Seedling Co., Angers, France.

Insects.

Scale, Oyster Shell, on *Buxus*.
Jac. Smits & Co., Naarden, Holland; J. Verkade & Sons, Boskoop, Holland.
Emphytus cinctus on Manetti stock.
E. Bruzeau, Orleans, France; F. Delaunay, Angers, France; Franco-American Seedling Co., Angers, France; Franco-American Seedling Co., Ussy, France (2); Vincent Lebreton's Nursery, La Pyramide-Trelaze, France.
Aleyrodes Sp. on Azalea. M. Debaerdemaeker, Everghem, Belgium.
Aphis, Woolly, on Apple Roots. Franco-American Seedling Co., Ussy, France.
Malacosoma neustria, Egg mass. K. Rosbergen & Son, Boskoop, Holland.
Acronycta rumicis. F. Delaunay, Angers, France.
Acronycta rumicis. Cocoons. Vincent Lebreton's Nursery, La Pyramide-Trelaze, France.
Empty Dipterous Pupae on Azaleas. W. C. Hage & Co., Boskoop, Holland.
Empty Sawfly Cocoon. M. Debaerdemaeker, Everghem, Belgium.
Lepidopterous larva in packing material. J. Blaauw & Co., Boskoop, Holland.
Leaf Miner, Work in Holly. Jac. Smits & Co., Naarden, Holland.

INSPECTION OF APIARIES.

This work has been done in about the same manner as in former years, Mr. H. W. Coley of Westport covering Fairfield, New Haven, Middlesex and New London counties, and Mr. A. W. Yates of Hartford covering Litchfield, Hartford, Tolland and Windham Counties. Each inspector has been paid by the day and expenses for the time worked, from the appropriation made by the legislature for this purpose.

In 1917, 473 apiaries were inspected as against 467 in 1916, and though nearly all expenses have increased, the costs per apiary and per colony are slightly less than last year. Eighty-four towns were visited as against 96 last year. In 1917 apiaries were inspected in the following 18 towns where no inspections were made in 1916: Branford, North Branford, Durham,

Middletown, Portland, Kent, New Hartford, Plymouth, Roxbury, Thomaston, Watertown, Woodbury, Burlington, Canton, New Britain, Newington, Sterling and Woodstock.

European foul brood was found in each county in the state and in the following 37 towns: Bethel, Fairfield, Huntington, New Canaan, Norwalk, Ridgefield, Stamford, Weston, Westport, Ansonia, Madison, Middlebury, Naugatuck, Waterbury, Wolcott, Durham, Lisbon, Montville, New London, Norwich, Waterford, New Milford, Plymouth, Bloomfield, Bristol, East Windsor, Farmington, Manchester, New Britain, Plainville, Southington, Coventry, Plainfield, Pomfret, Putnam, Sterling and Windham. The percentage of apiaries and colonies infested was considerably lower than in 1916. American foul brood was found only in the town of Old Lyme in New London County. Of the 473 apiaries containing 4,506 colonies examined, 90 apiaries containing 241 colonies, or about 19 per cent., were found diseased.

The statistics of the apiaries inspected in each of the 84 towns in each of the eight counties may be found in the following tables, the summary occurring on page 245:

APIARIES INSPECTED, 1917.

	No. Apiaries Inspected	No. Apiaries Diseased*	No. Apiaries Quarantined	No. Colonies Inspected	No. Colonies Diseased*
FAIRFIELD COUNTY.					
Bethel	5	1	0	29	2
Bridgeport	1	0	0	5	0
Danbury	1	0	0	6	0
Darien	2	0	0	59	0
Easton	3	0	0	105	0
Fairfield	8	2	0	160	2
Greenwich	5	0	0	44	0
Huntington	4	2	1	99	3
New Canaan	3	1	0	35	6
Norwalk	7	1	0	60	1
Redding	6	0	0	51	0
Ridgefield	3	1	0	16	1
Stamford	14	2§	0	164	2§
Stratford	4	0	0	113	0
Trumbull	1	0	0	68	0
Weston	5	1	0	30	1
Westport	8	1	0	97	1
Wilton	9	0	0	164	0
	89	12	1	1305	19

* European foul brood unless otherwise indicated.

§ One with European foul brood and one with sacbrood.

NEW HAVEN COUNTY.					
Ansonia	1	1	0	14	1
Beacon Falls	1	0	0	12	0
Branford	1	0	0	4	0
Cheshire	8	1‡	0	79	2‡
Derby	5	1‡	0	89	1‡
Guilford	2	0	0	9	0
Hamden	2	0	0	13	0
Madison	3	1	0	46	4
Meriden	15	2‡	0	141	3‡
Middlebury	1	1	0	40	6
Milford	5	0	0	58	0
Naugatuck	6	3	0	42	11
North Branford	1	0	0	5	0
North Haven	4	0	0	104	0
Prospect	10	0	0	98	0
Seymour	1	0	0	18	0
Waterbury	10	5	5	58	32
Wolcott	1	1	0	9	3
	77	16	5	839	63
MIDDLESEX COUNTY.					
Durham	2	1	0	71	10
Middletown	2	2¶	0	14	5¶
Portland	1	0	0	52	0
	5	3	0	137	15
NEW LONDON COUNTY.					
Lisbon	2	1	0	5	1
Montville	9	4	0	52	6
New London	1	1	0	14	4
Norwich	7	3	0	164	3
Old Lyme	2	2†	0	57	8†
Waterford	2	1	1	63	21
	23	12	1	355	43
LITCHFIELD COUNTY.					
Kent	5	0	0	63	0
New Hartford	1	0	0	32	0
New Milford	18	5	0	90	12
Plymouth	3	1	0	20	1
Roxbury	1	0	0	13	0
Thomaston	14	0	0	43	0
Watertown	7	0	0	63	0
Woodbury	1	0	0	27	0
	50	6	0	351	13

† American foul brood.
‡ Sacbrood.
¶ Bee paralysis.

HARTFORD COUNTY.					
Berlin	16	0	0	104	0
Bloomfield	11	3	0	207	6
Bristol	7	3	0	55	4
Burlington	4	0	0	26	0
Canton	7	0	0	21	0
East Hartford	3	0	0	42	0
East Windsor	16	3	0	113	13
Farmington	27	8	0	119	18
Glastonbury	17	0	0	90	0
Hartford	4	0	0	18	0
Manchester	13	8‖	0	93	12‖
New Britain	13	2	0	116	12
Newington	1	0	0	2	0
Plainville	7	2	2	28	5
Southington	5	2	0	33	4
South Windsor	3	0	0	20	0
West Hartford	2	0	0	26	0
	156	31	2	1113	74
TOLLAND COUNTY.					
Andover	2	0	0	7	0
Bolton	2	0	0	4	0
Coventry	6	1	0	50	1
Ellington	10	0	0	60	0
Mansfield	4	0	0	50	0
Vernon	4	0	0	57	0
	28	1	0	228	1
WINDHAM COUNTY.					
Brooklyn	3	0	0	20	0
Killingly	4	0	0	21	0
Plainfield	5	1	0	19	1
Pomfret	9	1	0	47	1
Putnam	5	1	0	13	1
Sterling	15	4	0	15	4
Windham	3	2	0	16	6
Woodstock	1	0	0	27	0
	45	9	0	178	13

SUMMARY OF APIARY INSPECTION.

County	No. Towns	No. Apiaries Inspected	No. Apiaries Diseased	No. Colonies Inspected	No. Colonies Diseased
Fairfield	18	89	12	1,305	19
New Haven	18	77	16	839	63
Middlesex	3	5	3	137	15
New London	6	23	12	355	43
Litchfield	8	50	6	351	13

‖ Two with sacbrood; others European foul brood.

SUMMARY OF APIARY INSPECTION—*Continued.*

County	No. Towns	No. Apiaries Inspected	No. Apiaries Diseased	No. Colonies Inspected	No. Colonies Diseased
Hartford	17	156	31	1,113	74
Tolland	6	28	1	228	1
Windham	8	45	9	178	13
	84	473	90	4,506	241

	Apiaries	Colonies
Number inspected	473	4506
Infested European foul brood	79	219
Per cent. infested	16.7	4.86
Infested American foul brood	2	8
Per cent. infested	.42	.17
Pickled or sacbrood	7	9
Bee paralysis	2	5
Average number of colonies per apiary		9.52
Cost of inspection		$749.51
Average cost per apiary		1.58
Average cost per colony		.166

European foul brood was reported by Dr. Phillips from Wethersfield and Thompson.

SUPPRESSION WORK AGAINST THE GIPSY AND BROWN-TAIL MOTHS.

By W. E. Britton and Irving W. Davis.

The work against these two pests has been conducted as in preceding years. Mr. Davis has had supervision of the field work under the State Entomologist, and since June 1, 1917, has been assisted by Mr. John T. Ashworth, who has had much experience in this work, being formerly employed by the Gipsy Moth Commission of Massachusetts, and more recently by the Bureau of Entomology of the U. S. Department of Agriculture.

The scouts and other employees necessary have been hired as needed. Some of the scouts have worked for us for several seasons, and have also been employed by the Federal Bureau of Entomology. Others have taken up the work more recently and have received their training by working with the other men in the scouting crews. The force has been impaired, and the work interrupted by men accepting other positions or entering the military service of their country. It is very difficult at present to obtain any kind of help, and much more so the character and type of men who develop into good scouts.

In all of this work the most cordial co-operation has existed between this office and the Federal Bureau of Entomology, and we wish especially to express our thanks to Messrs. A. F. Burgess and L. H. Worthley, who have been in charge of the work for the Bureau.

For the control of the brown-tail moth we have continued clipping off and destroying the winter nests; for suppressing the gipsy moth, the work has consisted of scouting and creosoting egg-clusters, spraying badly infested areas, and banding and destroying caterpillars in and around the colonies or infestations.

New Equipment.

But little new equipment was purchased during the past year. The Ford touring car was turned in toward a new one in the first part of the spring and this has been used by Mr. Ashworth in his work. It is not proving as good as the older model. A four-cylinder Buick touring car was also purchased and has been used by Mr. Davis. As the territory grows, more money and time are saved by the use of automobiles, for many of the towns, such as Ashford and Voluntown, are miles from a railroad.

Employees Who Have Entered Military Service.

The following men have enlisted in the Army or Navy:
Sergt. George D. Stone, Battery D, 56th Mobile Artillery.
Adolph D. Jarvais, Battery D, 56th Mobile Artillery.
William Lord, U. S. Naval Reserve.
George Benoit, Medical Corps.
Clifford A. Ladd, U. S. Navy.
W. Floyd Logee, U. S. Navy.
Charles A. Burdick, 174th Aero Squadron.
James A. Knight, Depot Brigade, Camp Devens.

Brown-Tail Moth Work.

Though this insect now covers the eastern half of the State, it has not spread appreciably during the last two years. In fact, it is difficult to find webs in most of the area supposed to be infested. Last season the webs were so scarce, even in towns which had formerly been heavily infested, that it was not thought necessary to notify these towns to remove and destroy the webs

as was done in 1916. Some scouting was done, however. Men were sent to examine the towns just west of the quarantined area, but no new towns were found infested. Small colonies were located within the quarantined area at New London and Stonington and the webs were removed and destroyed. A few webs were gathered in Canterbury, Bozrah and Preston for Mr. Burgess to use in his parasite work, but even here they were so scarce that the desired number could not be obtained.

Our men were on the watch for adults around lights in various cities and villages in July, but none were observed.

Gipsy Moth Work.

The gipsy moth situation presents an entirely different aspect, however, as there were a large number of single egg-cluster infestations ("singles") throughout the towns in the northeastern corner of the State. This would indicate another but shorter windspread than that of 1913.

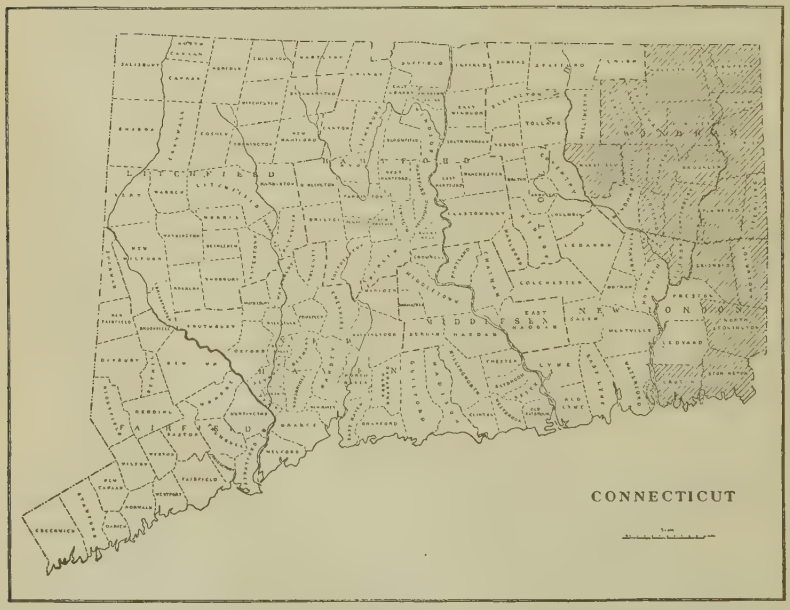

Figure 1. Map of Connecticut, shaded portion showing area now infested by the gipsy moth.

Further south and west an increase was also noted, as in Canterbury, Brooklyn, Hampton and Eastford, while Ashford showed a small decrease. Mansfield for the first time appears in the list of infested towns, two infestations being found near the eastern border of the town. This is the first time the gipsy moth has been taken in Tolland County. The area now infested is shown in figure 1.

Since our funds were limited and some of the towns had shown but few if any infestations in the past few years, it was thought best to scout only restricted portions of certain towns, as in the case of Sterling, Plainfield, Griswold, North Stonington, Stonington, etc. Three of the towns; namely, Sprague, Lisbon and Groton, were not scouted at all. We have planned to scout the entire infested area this coming winter.

The spraying was done with the horse-drawn power sprayer owned by the State and a power-truck sprayer which was lent to us by the Government. The former was used in Thompson, Putnam and Killingly where the infestations were the heaviest and near together. The Government sprayer was used in towns where the infestations were scattering and we were thus able to spray colonies in North Stonington, Canterbury, Hampton and Eastford. Altogether 91 separate infestations were sprayed.

With so many single infestations, it was impossible to band trees near all of them, and therefore only the larger colonies were thus treated. Every effort was made to visit all of the infested localities during the caterpillar season, and in this manner over 37,000 of the gipsy moth larvae were killed, besides those caught in the bands or poisoned by the spraying.

The food plants of the gipsy moth are very numerous but those most favored are apple, oak, willow and alder, while such trees as ash and the evergreens are seldom attacked. In Connecticut the woodland in the infested area consists largely of the various species of oak, with but few evergreens, and this section therefore offers an excellent chance for the spread of this pest.

Parasites.

There are several native insects and some birds that feed on the gipsy moth, but these are not able to control the pest. In 1905 the United States Department of Agriculture introduced from Europe and Japan a number of parasites, some of which

have become well established in this country. The most important of these are the Calosoma beetle (*Calosoma sycophanta* Linn), a tachinid fly (*Compsilura concinnata* Meig.), and several small wasp-like insects (*Apanteles lacteicolor* Vier., *Schedius kuvanae* How., *Anastatus bifasciatus* Fonsc.). All of these mentioned have been colonized in Connecticut with the exception of *Schedius*, an egg parasite. These are, of course, very scarce in this State at the present time, and until they become more plentiful the artificial methods of control will have to be employed.

Some gipsy moth pupae collected in Canterbury in November, 1917, were infested with a white mold or fungus, which has been identified by Mr. A. T. Speare, Bureau of Entomology, as *Isaria farinosa* (Dicks) Fr., a species previously recorded from Massachusetts on gipsy moth pupae.

Present Status of Parasite Work in Connecticut.

The following tabulated information regarding parasites introduced into, and recovered from Connecticut, has kindly been furnished by Mr. A. F. Burgess:

Compsilura concinnata Meig.

	1912	1913	1914	1916	1917
Colonized:	Putnam	Hartford	Plainfield Mansfield Stonington	Suffield Stafford Colchester Norwich Old Lyme	Scotland Hampton
Recovered:			1915	1916	1917
			Woodstock	Stonington	Putnam Plainfield No. Stonington

Zygobothria nidicola Towns.

This species has never been colonized in Connecticut, but in 1917 was recovered from Canterbury and Waterford.

Apanteles lacteicolor Vier.

	1912	1913	1915	1916	1917
Colonized:	Putnam	Suffield	Manchester	East Lyme	Montville
		Hartford	Chester	Canterbury	Groton
		Mansfield	Lebanon		
		Norwich			
		Stonington			
		Griswold			
		Plainfield			
		Killingly			
		Hampton			

	1913	1914	1915	1916	1917
Recovered:	Thompson	Waterford	Stonington	Killingly	Canterbury
	Woodstock	Hartford	Lebanon	Brooklyn	
	Pomfret		Suffield	East Hartford	
	Stafford			Wethersfield	
	Somers				

Meteorus versicolor Wesm.

	1916	1917
Colonized:	Colchester	Lyme
	Waterford	
	Ledyard	

	1914*	1916
Recovered:	Hartford	Woodstock
		Thompson
		Killingly
		Brooklyn

Anastatus bifasciatus Fonsc.

Colonized: 1917

Town	Number of Colonies
Thompson	21
Woodstock	5
Putnam	3
Killingly	6
Pomfret	3
Eastford	2
Brooklyn	3
Hampton	5
Chaplin	1
Mansfield	1
Canterbury	1
Total	51

*Note: It is probable that many of the earlier colonies of *A. lacteicolor* also contained a few cocoons of *M. versicolor*.

Each of these colonies contained 1,000 parasites, making a total of 51,000 parasites of this species liberated in Connecticut in 1917. Collections of gipsy moth eggs will be made in Connecticut this winter to determine the success of these colonies.

Calosoma sycophanta Linn.

Stonington:

On June 16, 1914, a colony containing 60 males and 50 females was liberated on Mr. E. P. Edwards' farm about one mile from depot, in an orchard almost defoliated by the tent caterpillar, *Malacosoma americana*, adjoining a wood lot where a gipsy moth egg-cluster had been found.

On the same date another colony, containing 60 males and 50 females, was liberated on York farm in the Anguilla district, about four miles from depot, in orchard infested with tent caterpillar, *Malacosoma americana*.

Up to January 1918, no recoveries have been made in the vicinity of these two Stonington colonies.

Thompson:

On July 6th, 1915, a colony containing 60 males and 50 females was liberated about 500 yards south of the Thompson railroad station.

On the same date a colony containing 60 males and 50 females was liberated in oak woodland on east side of electric railway, one mile south of Wilsonville, on property of the Grosvenordale Company.

On July 7, 1914, Mr. W. F. Kelly of the Federal Bureau of Entomology, while scouting woodland in Thompson, recovered and sent to the laboratory one male adult.

On September 12, 1916 the site and surroundings of both colonies mentioned above were scouted for larval molt skins or eaten pupae, but none were found.

Killingly:

On July 17, 1917, a colony containing 40 males and 50 females was liberated on property of C. O. Chase, near Putnam Heights, where a gipsy moth colony was found in 1916.

Mr. Harry L. Johnson of South Meriden took a specimen of this species near his home on May 24, 1915. So far as known the insect had not been planted within 40 miles of this locality.

Details of Gipsy Moth Work by Towns.

The following detailed account of the work in each town was prepared by Mr. Davis:

Thompson—518 infestations—2,837 egg-clusters.

Thompson continues to be one of the most thickly infested towns in the State. During last season 518 infestations containing 2,837 egg-clusters were located within its limits, and while there were a large number of infestations that contained only a single egg-cluster each, there were several that varied in size from 75 to 250 egg-clusters. The entire town is infested, but the eastern portion of the town is the worst, the infestations being more and more scattered as the work is carried west.

A year ago it was noted that a large number of infestations were found on the road leading from Brandy Hill to Webster, Mass. This road runs along the side of a ridge which in that section extends almost north and south, and from the top of this ridge eastward to the Rhode Island line the country was generally infested. Outside of this area large colonies which might be noted were those on the State road above Wilsonville, in a large oak near Quinebaug, and on the golf links near the Putnam town line.

The summer work was about the same as that done in previous years, namely, banding the trees around the infestation with either Tanglefoot or Raupenleim, the men attending to these bands every few days during the larval season and destroying all caterpillars which could be found there. The power sprayer was also used again and 49 of the largest colonies were sprayed with a mixture of arsenate of lead.

Scouts have already been doing some woodland scouting in this town, and several colonies have been located although but few singles have been found.

Woodstock—180 infestations—714 egg-clusters.

This town was scouted by men employed by the U. S. Department of Agriculture, as were many of the towns in the State, and the result was the finding of 180 infestations, only 30 of which contained more than a single egg-cluster.

A large number of singles were found in the vicinity of South Woodstock, but the larger infestations seemed to be in a line running from the northeast to the southwest corner of the town.

The largest colony was in the northeastern part of the town on land owned by Mr. A. T. Avery, where 130 egg-clusters were found on some pasture oaks.

The heaviest infested areas were banded during the summer and about 2,500 caterpillars were killed. The power sprayer was used in this town to spray seven of the worst infestations.

Putnam—163 infestations—488 egg-clusters.

Putnam is one of the towns in the northeastern portion of the State which have been heavily infested since the scouting was first started in 1913, and during the winter of 1916–17 one hundred and sixty-three infestations containing four hundred and eighty-eight egg-clusters were found.

As Putnam is a rather small town containing about twenty square miles, the number of infestations found shows Putnam to be about as thickly infested as Thompson, which lies to the north of it. A large number of singles were also located in this town, but most of the larger colonies were along the northern border. One exception to this was a group of infestations in some oak woods near the Killingly line. This woodland lies partly in Putnam and partly in Killingly and colonies of the gipsy-moth were found in these woods in both towns.

During the early part of the summer fourteen of the largest infestations were sprayed and in the course of the tanglefoot work which closed the last of July, over 9,000 caterpillars were destroyed besides those which were killed by spraying.

Pomfret—59 infestations—309 egg-clusters.

During the late summer and early fall of the year 1916, a crew of men worked in the western part of Pomfret at woodland scouting, but there were not many colonies located. In the winter the roadside scouting showed 59 infestations well scattered throughout the town. Only twelve of these colonies, however, contained more than one egg-cluster each, and the majority of these were in the woodland.

The largest of these infestations were banded early in the spring and the work of patrolling the banded areas was carried on until the end of July. During the spraying season, the Federal sprayer was used in Pomfret, and three of the worst infestations were sprayed.

Eastford—27 infestations—251 egg-clusters.

Just to the south-west of Eastford village, there is a large section of woodland with but a few farms scattered through it. In this area the most of the infestations found in the town of Eastford were located.

Although the most of the colonies were in the section noted, the largest infestation in Eastford, which contained 106 egg-clusters, was found about a mile northwest of the village near the Woodstock line.

Three of these infestations, including the last one mentioned, showed several larvae in the early part of the season and these were sprayed with arsenate of lead during the latter part of June. The banded trees were inspected as in previous years and continued until the latter part of July, when the season closed.

Ashford—2 infestations—3 egg-clusters.

In Ashford, only two infestations of the gipsy-moth were found last winter, and these were both near the eastern side of the town. They were both banded and patrolled but during the summer work only one gipsy-moth caterpillar was found.

Killingly—182 infestations—622 egg-clusters.

This is a rather large town, covering an area of about fifty-two square miles and extending for nine miles north and south along the Rhode Island line. In the northern portion of Killingly the infestations were rather heavy, both as regards colonies and single egg-cluster infestations. Toward the south part of the town there were no large colonies, and there was a marked decrease in the number of singles found.

It was impossible to band the trees around all of the single infestations, so only the larger colonies were thus treated, although all of the infested localities were visited during the patrolling work in the summer. Early in the month of July three of the worst colonies were sprayed.

Brooklyn—41 infestations—305 egg-clusters.

The eastern portion of the town contained a majority of the infestations, but these were practically all single egg-clusters. The largest colony in Brooklyn was located just to the west of Tatnic Hill, and here one hundred and ninety-seven egg-clusters were creosoted. Smaller colonies were found on Barrett Hill

in the northern part of the town, and in a maple swamp a little west of Church Street. The larger colonies were banded with tanglefoot and during the patrolling work over 5,000 caterpillars were destroyed. The season closed the latter part of July.

Hampton—30 infestations—248 egg-clusters.

With the exception of a group of infestations in the northern part of the town near the Pomfret line, the gipsy moth colonies were well scattered throughout the town. In this group were several colonies, but the two largest infestations were found in other parts of the town, one being in the west portion near Chaplin, while the other was in the east side about a half a mile from the Brooklyn line.

At one of the colonies in the group already noted, a large number of caterpillars were found in the early part of the summer, but prompt work caused a decided decrease in the number of larvae and it is believed that this colony has been destroyed. The spraying of a colony has proven to be a very effective means of combating this pest, and seven of the largest colonies in Hampton were thus treated during the last season.

Chaplin—4 infestations—34 egg-clusters.

The result of the scouting in the town of Chaplin last winter was the finding of four gipsy-moth colonies, the largest of which was a woodland colony in the northeastern section of the town on land owned by Mr. W. H. Phillips.

This infestation, together with the others in this town, was carefully watched until the end of the larval season, our work closing the latter part of July.

Mansfield—2 infestations—76 egg-clusters.

The town of Mansfield was found to be infested with the gipsy-moth in the year 1916 for the first time. Two infestations were discovered by scouting, and both were near the Chaplin line. One was a single while the other was a woodland colony of seventy-five egg-clusters. At the former infestation, no larvae were found during the summer work, but at the latter several were taken and the nearby foliage was sprayed with arsenate of lead.

Sterling—7 infestations—7 egg-clusters.

Since there were no infestations of the gipsy-moth found in Sterling in the winter of 1915–16, it was not thoroughly scouted

during the past winter. The work which was done in this town revealed seven infestations of one egg-cluster each.

Plainfield—1 infestation—29 egg-clusters.

There was only one infestation found in the scouting which was done in the town of Plainfield during the last winter. This colony contained twenty-nine egg-clusters, and was located a little north of the colony found the previous year. The colony did not appear very serious, for while several larvae were taken in the earlier part of the summer, only a few were taken after the first of July.

Canterbury—27 infestations—81 egg-clusters.

This town in the past few years has had many colonies located in the northern portion, and again this last season the majority of the colonies were located there. Other colonies were scattered throughout the town, but the only two important colonies were in this group. Both of these appeared serious early in the month of June, and as was the case in the other infested towns, the patrolling work was kept up until the end of July.

Scotland—4 infestations—9 egg-clusters.

The four infestations in the town of Scotland contained in all but nine egg-clusters, and although these were attended during the larval season, only eleven caterpillars were found, and those during the early part of the season.

Voluntown—4 infestations—4 egg-clusters.

Only portions of Voluntown were scouted during the winter of 1916–17 and but four single infestations were found.

Griswold—1 infestation—6 egg-clusters.

One colony containing six egg-clusters was brought to light by the scouting which was done in Griswold the last season. The trees around this colony were banded with raupenleim, and during the early part of the season a number of caterpillars were found, but none were taken after the middle of July.

Lisbon—Sprague.

No scouting was done in these two towns last winter. They have never had many infestations, and during the winter of 1915–16 nothing was found withing their limits, so it was decided to use the money elsewhere this year.

North Stonington—3 infestations—147 egg-clusters.

In the past two years the infestations found in this town have all been in one section so that this past season only that section was scouted. Three infestations were found and these contained 147 egg-clusters, all but six of which were in one colony. This colony was on land owned by Mr. William Rathburn and was situated in the southeastern part of the town. As this colony was of a serious nature it was sprayed early in the season, as was also one of the other colonies where several caterpillars were found.

Stonington—2 infestations—12 egg-clusters.

The section of Stonington which was scouted last winter showed only two infestations of twelve egg-clusters, but neither of these were of a serious nature.

Groton—No scouting was done in this town last year.

STATISTICS OF INFESTATIONS.

The following table summarizes the work by towns:

Towns	No. of Infestations	No. of Egg-clusters Destroyed	No. of Bands Applied	No. of Infestations Sprayed	No. of Larvae Destroyed
Thompson	518	2,837	8,517	49	12,945
Woodstock	180	714	2,171	7	2,620
Putnam	163	488	1,786	14	9,626
Pomfret	59	309	991	3	92
Eastford	27	251	1,079	3	904
Ashford	2	3	34	0	1
Killingly	182	622	1,410	3	1,841
Brooklyn	41	305	794	0	5,449
Hampton	30	248	133	7	1,413
Chaplin	4	34	229	0	741
Mansfield	2	76	11	1	45
Sterling	7	7	0	0	0
Plainfield	1	29	37	0	212
Canterbury	27	81	228	2	1,405
Scotland	4	9	118	0	11
Voluntown	4	4	0	0	0
Griswold	1	6	24	0	95
Lisbon	0	0	0	0	0
Sprague	0	0	0	0	0
North Stonington	3	147	128	2	400
Stonington	2	12	0	0	0
Groton	0	0	0	0	0
Total	1,257	6,182	17,690	91	37,800

EXPERIMENTS IN SPRAYING APPLE ORCHARDS TO CONTROL APHIDS AND FALSE RED-BUG.

By W. E. Britton and M. P. Zappe.

For several years there has been much damage to the fruit crops in certain apple orchards from the attacks of red bugs and aphids. The false apple red bug, *Lygidea mendax* Reut., is responsible for the red bug injury (See Plate III) as the true red bug, *Heterocordylus malinus* Reut. has not yet been found in Connecticut. The false or lined red bug was first observed in Greenwich in the southwest corner of the State and it has caused injury there each year since, and has gradually extended northward and eastward. We have no evidence to show that it occurs throughout the State, though probably such is the case. Certainly, orchards here and there are not injured by it and it seems to be more prevalent in the southwestern portion than elsewhere in the State.

The rosy apple aphis, *Aphis sorbi* Kalt., is the species chiefly responsible for the aphid injury to the fruit. This species attacks the leaves and young fruit of the fruit clusters, dwarfing and deforming the apples, while the green apple aphis, *A. pomi.* Degeer, occurs more particularly on the leaves of water sprouts and terminal twigs. During 1917 the rosy aphis was also on the foliage of the terminal branches, but it is usually found in more shaded situations inside the crown or head of the tree.

In order to obtain data regarding the effect of nicotine sprays on these insects, some tests were conducted in the orchards of S. A. Smith & Son, Clintonville, and Frank N. Platt, Milford. The details of the treatment and results obtained are given with comments under the headings below. The fruit was not thinned in either orchard. All fruit was examined at harvest and scored as regards all insect injuries. This required a careful inspection of 98,652 apples.

Smith's Orchard, Clintonville.

The orchard consists of 6 rows of trees running nearly north and south with 11 trees in a row. The rows were numbered 1–6, beginning on the east side. Beginning at the north end the trees were numbered 1–11; the first five trees in each row are

Baldwins, the next tree is an Ohio Nonpareil, and the other five are Greenings, except for a tree here and there which has been top-grafted to Opalescent.

On May 21, four rows of trees in this orchard were sprayed with the following mixture:

Black leaf 40	1 pint
Lead arsenate (powder)	2½ lbs.
Commercial lime-sulphur	2 gal.
Water	100 gal.

Rows 2 and 5 were left as checks and were not treated with nicotine solution but were sprayed later with lead arsenate and lime-sulphur. A few trees were not sprayed at this time because the blossoms were nearly open and bees were working in them. These exceptions were tree No. 6 in each row (all Ohio Nonpareil) and tree No. 9 in row I, and trees Nos. 9 and 10 in row III (Greenings).

The spraying outfit consisted of a kerosene tractor used to work the pump and to haul the 100-gallon spray tank. A small gasoline engine mounted on the spray-tank was used to agitate the mixture. This outfit is shown on Plate II, b. The spray was applied from two lines of hose, throwing in opposite directions. One man sprayed up through the tree and the other down from the top. The pressure used was from 175 to 200 lbs. The weather conditions were ideal for spraying.

The second spraying with nicotine solution was given only to rows I and VI on June 4. The rest of the orchard was sprayed with lead arsenate and lime-sulphur but no Black Leaf 40 was used.

The fruit was picked and scored during the week of September 24–29.

The red bug injury was not serious in this orchard and it was difficult to find specimens. Nevertheless, the insect was present and was hatched from twigs cut early in the spring. The injury was slightly reduced by the treatment.

Aphids were a much more serious menace, however. Certain trees showed a large proportion of aphis apples at harvest. This injury was greatest on one of the check rows and was least where two treatments were given. A summary of the results appears in the following table:

Summary of Results of Spraying Treatments.

Row	Good Per Cent.	Red Bug Per Cent.	Aphis Per Cent.	Codling Moth Per Cent.	Curculio Per Cent.	Maggot Per Cent.	Other Chewing Insects Per Cent.	Total Number of Apples Per Row
1	74	01	19	02	004	01	02	7,809**
2	61	02	31	02	005	002	03	9,183‡
3	63	009	32	02	001	002	02	8,388*
4	71	006	23	02	01	003	02	14,947*
5	54	02	35	04	02	001	03	11,696‡
6	80	002	10	04	02	008	02	11,552**

Platt's Orchard, Milford.

The section of orchard used in these tests has 8 rows of trees running nearly east and west. The four rows on the north side are Baldwin and the other four rows are Greening, Smokehouse, White and King. The rows were lettered A to H from south to north, and the trees in each row numbered 1 to 12 from west to east. The two rows in the center of the orchard were not sprayed with nicotine but left for checks. This orchard was given only one spraying and that on the afternoons of June 12, 13, 14 and 15, after the petals had fallen. The spray outfit was a common horizontal cylinder hand pump, mounted on a 100-gallon tank. Two lines of hose were used, one man spraying from a tower on the tank and the other from the ground. The pressure was not sufficient for the best results, as the trees were compact and the foliage was heavy. With this pressure the spray could not be driven through the crown of the tree. The fruit was picked and scored on August 31, October 4, 8, and 18. The crop was very light—especially the Baldwins—many trees having no fruit at all.

There was much red bug injury in this orchard. Some had already been done before the nicotine was applied. There was also considerable injury from aphis, which would in part have been prevented by an earlier application. The spray mixture was substantially the same as used in the Smith orchard. See page 260.

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* One treatment.
‡ Check.
** Two treatments.

A summary of the results are given in the following table:

SUMMARY OF RESULTS OF SPRAYING TREATMENT.

Row	Good Per Cent.	Red Bug Per Cent.	Aphis Per Cent.	Codling Moth Per Cent.	Curculio Per Cent.	Maggot Per Cent.	Other Chewing Insects Per Cent.	Total Number of Apples Per Row
A	53	12	27	01	002	02	03	10,032
B	47	20	31	004	002	002	02	6,886
C	48	28	21	007	004	004	03	6,584
D*	37	44	15	007	002	001	03	7,018
E*	30	39	26	005	003	0	04	1,873
F	66	13	13	01	0	0	09	573
G	60	07	21	02	002	0	09	1,576
H	56	0	37	02	0	0	04	535

We believe that the spraying should be done earlier next year. The branches should be thinned out to let in more light and air. More effective spraying can unquestionably be done with larger pump or power outfit, capable of maintaining a pressure of from 200 to 300 lbs. per square inch.

We hope to continue the experiments another year.

THE STRIPED CUCUMBER BEETLE.

Diabrotica vittata Fabr.

Order Coleoptera; Family Chrysomelidae.

By QUINCY S. LOWRY.

For the past few years Connecticut gardeners have had considerable difficulty in growing cucumbers and squashes, due to the fact that the striped cucumber beetle has been so destructive. Consequently, in 1916 and again in 1917, one-half acre of ground was set aside at the Station farm at Mt. Carmel to carry on field experiments for controlling this and other pests of the cucumber and squash.

These small, yellow and blacked striped beetles, shown on plate IV, b, and in figure 2, are voracious feeders, not only on cucumbers but other cucurbitaceous plants, often causing the entire destruction of the first planting. In both 1916 and 1917 these beetles necessitated a complete second sowing of seed.

DISTRIBUTION AND HISTORY.

The striped cucumber beetle is especially abundant and destructive in the United States east of the Rocky Mountains and

* Rows D and E, checks.

is distinctly a native pest. As early as 1843 it was reported as an injurious insect, and in 1864 Dr. Fitch* published an article on the beetle in which he states that for more than twenty years he has had to protect his cucumber vines against the attack of these beetles.

In 1781 this beetle was described by Fabricius, in his Species of Insects, Vol. I, p. 148, under the name *Cistela melanocephala*, or the "Black-headed Cistela." A few years afterwards it was placed by him in the genus *Crioceris*, but as there was already another species having the same name he renamed it *vittata*, or "Striped Crioceris." Inasmuch as this beetle was not known at this time to be a pest outside of America, Gmelin gave it the name *Cryptocephalus americanus*, which was quite appropriate. Shortly after, Olivier determined the place of this insect to be in the genus *Galeruca*. Chevrolat, however, proposed a division of this genus, giving it the name *Diabrotica*, in which it has since remained.

Food Plants.

It is well known that this beetle feeds not only on the cucumber, squash and melon, but on all related *Cucurbitaceae*. It is frequently found feeding on the foliage of other vegetables, and the past season attacked the leaves of young peas and beans at the Station farm. Sirrine of New York, in 1899, reported that it feeds on the flowers of the apple, cherry, choke cherry and wild balsam apple. In 1916 a row of peanuts, *Arachis hypogoea* Linn., adjoining this field were found infested with these beetles. They are quite frequently found feeding on goldenrod and sunflower blossoms.

Injury.

These beetles feed during the whole season from late in the spring until October or later in the fall on cultivated or wild plants. The greatest amount of damage is caused by the adults just as the plants start out of the ground. The beetles attack the cotyledonous leaves, and in 1916 they had destroyed the entire crop before the majority of these leaves had appeared above ground. Although the greatest loss is caused at this time,

* 10th Report, Fitch's Noxious Insects of New York.

later in the season they feed on the stems of the vines and also on the flowers. This causes a weakening of the vines and to some extent prevents the setting of the fruit. The larvae feed on and tunnel in the main stems; (see Plate V); however, the damage caused by the larvae is not to be compared with that of the adult because after the stalks start to shoot out running vines they are generally vigorous enough to stand the attack from these insects. They prefer only the young and most tender parts of the plant and when the plants become woody the beetles cause no more damage except to the leaves and blossoms. It is, therefore, evident that the most damage is done when the plants are small, and the wilting of the vines, due to the work of the larvae, is not very great. The mining of the stems by the larvae has not very much immediate effect on the plants but this season there was an increased tendency of both cucumber and squash vines to develop certain forms of fungous diseases.

The loss incurred by disease due to the feeding of the larvae has been estimated at from ten per cent. to forty per cent. of the crop. Several cucumber vines this year, when from two to three feet long, became infested with a wilt, determined by the botanist of the Station to be the Fusarium wilt. Some of the more common diseases of cucumbers occurring in Connecticut are the downy mildew, *Pernoplasmopara cubensis* (B. & C.), Clint., and anthracnose, *Colletotrichum lagenarium*. This season there was comparatively little damage done to the fruit; nevertheless, the larvae work in the rinds of the fruit, causing a warty appearance. The feeding of the larvae also provides for the growth of rots and bacterial diseases. These beetles, besides being destructive to cucumbers, cause considerable damage to melon and squash, especially in market garden sections. They cause the most loss in sections where there is a scarcity of wild flowers. These beetles originally fed on the blossoms of such flowers as the goldenrod and wild species of the gourd. Although at the present time they do feed on some wild flower blossoms, they prefer to remain in vegetable gardens until the cold weather drives them to their hibernating quarters.

Life History.

ADULT. The beetles emerge from their hibernating quarters in May and June, although a few beetles may be found during

warm sunny days in April. The beetles appearing early are undoubtedly the ones that do not go into the ground to hibernate but find suitable quarters in farm buildings. The ones appearing early feed on a large variety of food plants until the squash and cucumber plants break through the ground. At this time they are ravenous feeders and usually feed a week or ten days before mating. The adults have a habit of hiding in cracks in the ground and cause considerable damage before one realizes that they are present in any great numbers. Some days, especially when it is cloudy, scarcely any beetles can be found in sight, but if the earth is disturbed a great many of them will fly about. They not only hide in the loose soil but also on the under side of the leaves. They soon begin to mate and the females shortly after begin to lay eggs. The tendency to pair is very strong and this often continues long after the egg-laying period.

EGG. The eggs are laid promiscuously (see plate IV, a), the female dropping them in crevices of the soil near the stems of the plants. They are also commonly found underneath the leaves; in fact, it appears that the female drops eggs anywhere she happens to be feeding or hiding. In the field the eggs are deposited singly. Sirrine reports that in all his field observations he had never found eggs deposited in clusters although females in confinement deposited a great many eggs in a few hours, a large proportion of these being laid in clusters. The number of eggs deposited varies from about thirty up to one hundred. The largest number ever observed deposited by a single female is one hundred and seventeen. From recent observations the female deposits all of her eggs in a single season. Some female beetles which have been kept in captivity have been known to lay eggs a second season. This was the case of a female of *Calosoma frigidum* Kirby, according to Mr. Burgess. The hatching period of the striped beetle eggs varies according to the temperature. Experiments have proved that in an average temperature of 74°F. the eggs hatch in eight or nine days.

LARVA. The larval stage is passed in the soil and may be found in the stems or on the fruit where it touches the earth. The larvae, however, can only mature in moist earth. When the larvae first hatch, unless they have moisture they will live but a short time. It requires about a month from the time the egg hatches until the larva becomes full grown. It then leaves the

plant and makes an oval, earthen cell in moist earth in which it pupates.

PUPA. The pupal stage is passed in from six days in warm weather to two weeks in colder weather. In this locality there is but one generation annually, although in Washington there are at least two, and possibly three generations in a single season.

Description.

ADULT. The general appearance of the striped beetle is shown on plate IV, b; it is a glossy, bright lemon-yellow, rather small beetle with a black head. The antennae are also black with the exception of the first three joints, which are a yellowish color. They are about two-thirds the length of the body. The thorax is not quite as broad as the wing covers. There are two indentations on the upper side of the thorax a little more than half way from its center. The wing covers are oval in outline and slightly convex. Each wing cover has nine furrows running lengthwise; in each of these furrows there is a row of small punctures. There are three black stripes on the wing covers, the middle one being on the suture. The wings are of a gray-brown color. The beetle measures about two-fifths of an inch in length (see plate IV, b), and is nearly half as wide as long.

EGG. The egg is of a light yellow or lemon-yellow color and is shown on plate IV, a. It is somewhat smaller than some of the other species, such as *Diabrotica 12-punctata*, and averages 6 mm. in length and about half as wide. It has the same markings as those of *Diabrotica longicornis* Say, figured by Forbes in the 12th Report on Insects of Illinois, page 18.

LARVA. The larva is a small, slender, soft "grub," dull-white, with a dark brown head and anal plate, the thoracic plate being light brown in color. It measures about one third of an inch in length, and is about one-tenth as thick. It has six thoracic legs and one anal proleg. It is covered with a few scattering hairs.

PUPA. The pupa is of a yellowish-white color. Its appearance is rather unique inasmuch as the antennae, legs, wing and wing covers are enclosed in separate sheaths, thus being free from the body.

Adult, larva and pupa are shown in figure 2.

Parasites.

One of the most important natural enemies of the striped beetle is a tachnid fly, whose life cycle is passed within the adult beetle. This fly proves to be very destructive and undoubtedly helps greatly to keep this pest in check. It is known as *Celatoria diabroticae* Shimer.* Some of the ground beetles and certain species of ants feed on the larvae.

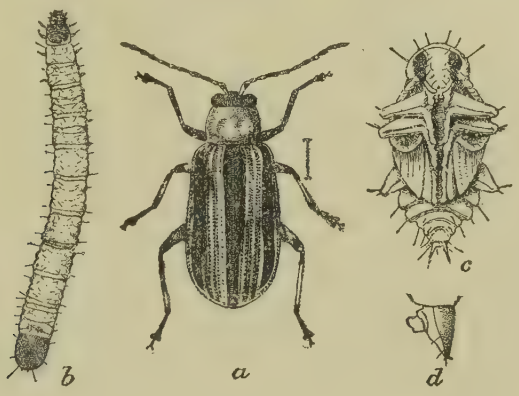

Figure 2. The striped cucumber beetle: *a*, adult beetle: *b*, larva; *c*, pupa; *d*, side view of anal segment. All greatly enlarged. (After Chittenden, Circular 31, Bureau of Entomology, U. S. Department of Agriculture.)

Field Tests in 1917.

The half acre used in this experiment was planted to twelve rows of cucumbers and fourteen rows of squashes. The treatments given were as follows:**

CUCUMBERS.

Rows 1, 2 and 3.	Land plaster or gypsum.
" 4 " 5.	Air slaked lime.
" 6 " 7.	Lead arsenate (Spray).
" 8 " 9.	" " (Dry).
" 10 " 11.	Fine coal ashes.
" 12.	Protectors.

* Chittenden, F. H. Insects injurious to Vegetables, Fig. 105, p. 157.

** The beetles were so abundant it was useless to leave any check rows. Consequently it was thought best to use the ground to the best advantage and try to protect all the rows without leaving any for check rows.

SQUASHES.

Rows 1, 2 and 3.	Fine coal ashes.
" 4, 5 " 6.	Lead arsenate (Dry).
" 7 " 8.	Black Leaf 40 and lead arsenate.
" 9.	Protectors.
" 10.	Black Leaf 40 and soap.
" 11.	Lime sulphur.
" 12.	Black Leaf 40 and lime-sulphur.
" 13 and 14.	Land plaster or gypsum.

The varieties used were Long Green cucumbers and Hubbard squashes. On April 24, strawberry boxes were used to plant the seeds. Twenty-five boxes were planted with cucumber seeds, using ten seeds in each box. Also twenty-five boxes of squash seed were planted using six in each. These were put in a greenhouse. On the 12th of May, out of 150 squash seeds planted, only 40 squash plants lived and 38 cucumber plants out of 250 seeds planted. Consequently it was necessary to replant these boxes with seeds. On May 24th and 25th one row each of cucumber and squash plants were set in the field from those started in the greenhouses and protectors placed over them like those shown on plate IV, c. The rest of the field was planted with seeds. The cucumber plants were all badly sunburned and consequently were replanted on May 31st. On June 14th and 15th the above-mentioned treatments were applied to the remaining plants, which were few. It was necessary, therefore, to plant over nearly all squash and cucumbers on June 16th.

On July 3d, in order to have a good stand several more seeds were planted in the squash plot, none, however, were planted in the cucumber plot. The protectors that were used on the cucumbers and squash were removed on this date, the plants filling the space under them.

Another application of remedies was made on July 5th, this being the last treatment given to the cucumbers.

Methods of Control.

Under ordinary conditions a great majority of these beetles can be controlled by spraying or dusting with arsenical poisons

but when they are abundant it is a difficult matter. It is, therefore, necessary to use more than one method in order to satisfactorily control this pest. Cultural methods, repellents, preventatives, and insecticidal methods are commonly practiced, collectively, to obtain the best results.

CULTURAL PRACTICES.

Clean culture is an important factor in controlling this pest. When the crop has been harvested, all refuse, including all the old vines, should be removed from the field and burned. This will destroy a great many of the beetles that would otherwise hibernate, and therefore lessen the number of beetles to attack the plants the following spring.

Plowing. After the crop has been harvested and all refuse removed, harrowing the ground lightly will kill many adults that remain near the surface before hibernating. Plowing deeply in the spring will also kill many hibernating adults.

Trap crops. Beans and squashes have often been planted as trap crops, especially by market gardeners who grow quantities of melons. Young squash plants are a favorite food of these beetles and are preferred by them to the cucumber. If squashes are planted in the spring, a week or ten days before the cucumbers or melons, the beetles will feed on them before the cucumbers push out of the ground. Then poison the squashes with arsenate of lead. Squashes or beans can also be planted around the borders of the field late in the season in order that the new generation of beetles can have tender food on which to feed. Those of the new generation feed before hibernating and if this food is provided, just as soon as they begin feeding upon it the young plants can be sprayed or dusted with an arsenical poison. This will kill many of the beetles before they seek winter quarters.

Rotation of Crops. A field that has been infested by these beetles should not be planted with cucurbits for at least two years, neither on nor near the previously infested ground. Rotation of crops for two, and better, three years, will lessen the infestation.

Fertilizers. The use of quick-acting fertilizers will enable the plants to make a quick growth. This will help them, to some extent, to outgrow the attack of the beetles.

Time of planting, etc. It is advisable in the early spring to start the plants in a greenhouse or in frames. If this is done early enough so that the plants are of a fair size when set out in the field, they will be able to withstand the attack of the beetles. If this cannot be conveniently done, it is well to plant nearly twice as many seeds to a hill as are necessary. Later, if more plants survive the attack than are needed, it is an easy matter to thin out to the desired number. Some vegetable growers recommend several plantings to be made a few days apart. This will undoubtedly prove more or less satisfactory, but it has the tendency to produce a late crop. In Connecticut, at least, it is important to produce cucumbers just as early as possible, before the market has been flooded.

PROTECTIVE METHODS.

Protectors. For many years coverings of some sort have been used as a protection for the young plants against the adult beetles. There are many different kinds of coverings on the market and many home-made devices are used. In 1916 protectors were purchased from Joseph Breck & Sons, Boston, Mass., to be used in connection with our field tests. At that time the price was $1.50 per dozen. These protectors have been used for two seasons and are shown on plate IV, c. A majority of these can be used at least another season without many repairs. Serviceable protectors can be made at home by cutting a barrel hoop in two, crossing the halves, and tacking the ends to another hoop. This frame is then covered with mosquito netting like those purchased. The protectors have proved satisfactory, although if the cloth becomes broken the beetles can crawl through. Wire screening is more substantial but more expensive. If the frames are covered with wire screening they can be used from year to year.

REPELLENTS.

Tobacco, Naphthalene. Many repellents have been used from time to time but without any particular results. Tobacco dust has been tried in Connecticut without great success, although it has the advantage of acting as a fertilizer. Naphthalene balls and flakes have been scattered around each hill without success.

Fine Coal Ashes. Finely sifted coal ashes heavily dusted around the plants are more or less satisfactory in keeping the beetles away.

Air-Slaked Lime. Dusting with air-slaked lime is an old time remedy and will prove successful when the beetles are not very abundant.

Lime-Sulphur. Spraying with lime-sulphur has given better results than some of the above-mentioned materials. If used 1 to 50, it will not injure the foliage.

Land Plaster or Gypsum. In using dry materials it is essential that the whole plant be thoroughly dusted. This is especially the case in using land plaster. If the leaves are merely covered with dust it will have the tendency to drive the beetles to the under sides of the leaves or to the stems of the plants. Where dry materials are used, the stems of many plants have been badly chewed near the surface, and sometimes beneath the surface of the ground. It is also true that even when the plants are covered with dust the beetles often feed on them.

ARSENICAL POISONS.

Arsenate of Lead. Arsenate of lead has been more successful in Connecticut than other artificial measures. This can be used either as a spray or dusted on the plants. When used as a spray, 3 pounds to 50 gallons of water is sufficient. Arsenate of lead can also be used in combination with other materials, such as Black Leaf 40 and lime-sulphur.

Arsenate of Lime. This was applied in the form of a spray (1 oz. in 1 gallon of water) at the Station farm in 1917. As this poison injured the foliage where used at this strength, it cannot be recommended.

CONTACT POISONS.

Black Leaf 40. Black Leaf 40, a nicotine sulphate solution, has been used alone and in combination with lime-sulphur and arsenate of lead. Two teaspoonfuls of Black Leaf 40, one-half ounce of soap, and two ounces of arsenate of lead is the formula used. When used alone or with lime-sulphur, this material was not very effective, but the addition of lead arsenate increased its effectiveness.

Results.

The following treatments proved effective in the order given in controlling the striped beetle in 1917. The materials used

have been explained in previous pages and the results are based on the number of plants that remained after all applications had been completed.

Cucumber:

1st. Protectors.
2d. Arsenate of lead spray.
3d. Arsenate of lead, dry.
4th. Land plaster or gypsum.
5th. Air-slaked lime.
6th. Coal ashes.

Squash:

1st. Protectors.
2d. Land plaster or gypsum.
3d. Arsenate of lead and Black Leaf 40.
4th. Arsenate of lead, dry.
5th. Black Leaf 40 and lime sulphur.
6th. Fine coal ashes.
7th. Lime sulphur.
8th. Black Leaf 40 and soap.

Summary.

When beetles appear in great quantities, they cannot be satisfactorily controlled by simply one method. It is therefore necessary to use different methods in combination. Some of the principal methods which will give satisfactory results are the following:

1. Protectors, young plants.
2. Arsenate of lead, dry; spray alone or in combination.
3. Dusting, arsenate of lead, land plaster, air-slaked lime.
4. Lime-sulphur spray.
5. Planting an abundance of seed; then thinning.
6. Clean culture in fall.
7. Trap crops; squash and beans in spring and fall.
8. Fertilizer used as stimulant.

Literature.

Britton, W. E. & Lowry, Q. S. Rept. Conn. Agr. Expt. Station, pp. 116–118, 1916.

Chittenden, F. H. Bulletin No. 19, n. s. Div. Ent. U. S. Dept. Agr. pp. 48–51, 1899.
Circular No. 31, Bur. Ent., U. S. Dept. Agr. 1909.
Insects Injurious to Vegetables, pp. 155–159, 1907.

Fitch, Asa. 10th Report of Noxious and Other Insects of the State of New York, pp. 443–440.

Headlee, T. J. Journal of Economic Entomology, Vol. I, pp. 203–209, 1908.

O'Kane, W. C. Injurious Insects, pp. 150–151, 1912.
Quaintance, A. L. Bulletin No. 45, Georgia Agr. Expt. Station, 1899.
Sanderson, E. D. Insect Pests of Farm, Garden and Orchard, pp. 379–383, 1912.
Sirrine, F. A. Bulletin No. 158, New York (Geneva) Agr. Expt. Station, May, 1899.
Smith, R. I. Bulletin No. 205, North Carolina Agr. Expt. Station, 1910.

THE IMPORTED PINE SAWFLY.

Diprion (*Lophyrus*) *simile* Hartig.

By W. E. Britton and M. P. Zappe.

This European pine sawfly was first discovered in this country at New Haven, Conn., in August 1914, by the writers, who, in company with Mr. Irving W. Davis, were inspecting the stock in one of the nurseries. The larvae were feeding upon the leaves of pine trees. As the inspection work continued for several days, we later found the larvae more abundant in another part of the nursery and considerable material was gathered and taken to the laboratory.

Though unfamiliar, we supposed this to be a native, and perhaps not uncommon species. A portion of the collected material was sent to Dr. Alexander D. MacGillivray of the University of Illinois, who was engaged in the study of sawfly larvae, and who at that time had finished preparing the manuscript of the *Tenthredinoidea* for the publication entitled The Hymenoptera of Connecticut, which has since appeared as Bulletin No. 22 of the Connecticut State Geological and Natural History Survey. Dr. MacGillivray was unable to identify the larvae but thought that he might recognize the species if the adults could be obtained.

The larvae in the breeding cages matured in due season and made their cocoons. From this material the first male emerged on April 8, 1915, followed by others, and on April 15 the first female appeared. Males and females were placed in cages containing potted white pines and the females soon laid eggs. On April 21, we wrote to Dr. MacGillivray, informing him of the emergence of the adults. He examined his own cages and found that the adults had emerged there also. He replied that they belonged to the genus *Diprion*, formerly known as *Lophyrus*, but that he did not recognize the species, several of which are

badly confused; that Mr. S. A. Rohwer of the Bureau of Entomology at Washington, D. C., was trying to straighten them out and had already examined many of the types in the British Museum. He suggested that specimens be sent to Mr. Rohwer.

Identity.

Following Dr. MacGillivray's suggestion, on May 6 material was sent to Mr. Rohwer, who soon replied as follows:

"I have determined this species, tentatively, as *Diprion simile* Hartig. The adults agree more closely with those in the collection under the name *pini* but the larvae answer exactly the description of *simile*, and as these two species are very closely allied and easily confused in the adults, I have made the determination from the larvae rather than from the adults.

"This species is one of the most injurious sawflies on European conifers and has been associated in practically all of the depredations caused by *pini*, and is recorded in the literature in a number of cases under the name of *pini*. You are, no doubt, familiar with the economic importance of *Diprion pini* in Europe. It is highly important that immediate measures be taken to combat this injurious insect as it has a large number of host trees and would no doubt adapt itself readily to the conditions in America, where, if it were thoroughly established without its parasites, it would do a great deal of damage."

Though two and one-half years have elapsed since Mr. Rohwer made this identification, and as he has studied the life history and food habits of the species from material furnished by us, a recent communication states that his subsequent observations serve to confirm his tentative identification. We may, therefore, consider it to be fairly well settled that this sawfly is the European *Diprion simile* Hartig. Some of the European writers place *simile* as a synonym of *pini*, but Dr. Enslin and certain other European specialists, as well as Mr. Rohwer, who has studied the species carefully from American and European material, consider them distinct.

Publications from this Department.

A brief account of the discovery of this insect in the United States was prepared with the help and approval of Mr. Rohwer, and this article, with a plate of illustrations, was published in the Journal of Economic Entomology, Vol. 8, page 379, June, 1915. A note, with figure of larvae, was also printed in Tree Talk, Vol. 3, page 45, November, 1915.

A more complete account, or at least complete at the time, of our observations on this insect was given with bibliography in the Report of this Station for 1915, page 118. This paper was illustrated by three plates (vii, viii and ix).

A brief paper, "Further Notes on *Diprion simile* Hartig," was prepared to be presented to the Columbus, Ohio, meeting of the American Association of Economic Entomologists in December, 1915, but in the absence of the writer this paper was read by title, and printed in the Journal of Economic Entomology, Vol. 9, page 281, April, 1916.

These papers just mentioned were all prepared by the senior author.

At the New York meeting of the American Association of Economic Entomologists in December, 1916, Mr. Zappe read a short paper entitled "Egg-laying Habits of *Diprion simile* Hartig," which paper appeared in the Journal of Economic Entomology, Vol. 10, page 188, February, 1917.

Since the publication of these papers some additional information has been obtained and all have been brought together in the present paper.

Distribution in Connecticut.

Though first discovered in New Haven, this insect was soon found in Derby, Hartford, Greenwich and New Canaan, five separate towns, and three distinct and rather widely separated regions in the State.

Distribution in the United States.

Diprion simile has now been recorded not only from Connecticut but also from the states of New York and New Jersey, where it was discovered in 1916. In New Jersey it is known to occur at South Orange, Elizabeth and Rutherford.* In New York it has been taken at Flushing, Long Island. In Connecticut, Massachusetts, Pennsylvania, New Jersey, Indiana, and doubtless in other states, cocoons have been found on imported nursery stock coming from Europe.

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* H. B. Weiss, Journal of Economic Entomology, Vol. 10, page 224, February, 1917.

Distribution and Damage in Europe.

This sawfly is mentioned in literature as occurring with *pini*† and therefore responsible for a portion of the damage.

In most cases, however, the serious injury is accredited to *pini*, which has seriously damaged the pine forests of Southwestern Russia‡, especially the young trees; *pini* was particularly destructive in France§ in 1906, and has also caused damage in Prussia and in Sweden. In England it is said to injure Scotch fir‖ as well as pine.¶

In 1914, larvae of *pini* nearly defoliated the ten-year old pine trees on one plantation in Norway.** The insect was reported from many localities. During the same year *pini* denuded many acres of pines in the districts of Achtyr and Izium in Russia,⊙ and caused much damage in Germany, particularly in Brandenburg and Silesia.△

Injury to Trees.

The injury consists in defoliation. The older and mature leaves, instead of the newly-formed ones, are eaten. In late summer the new growth may serve as food for the second brood larvae, so that in this manner the larvae when abundant are able to entirely defoliate trees. Plate VII, b, shows a tree of *Pinus cembra* about seven feet tall almost stripped by the larvae in 1915. Formerly it was supposed that a pine in this condition would not recover. In spite of the fact that the needles were eaten off, the buds were formed for the next season's growth, and the tree put out leaves in 1916 as usual, and as this foliage was protected by spraying, the tree did not seem to be permanently injured. If the tree had not been sprayed and the larvae abundant, the second brood larvae would doubtless have stripped it

† Kaltenbach, Die Pflanzenfeinde, page 700, 1874. Judeich-Nitsche, Forstinsektenkunde, page 635, 1895.

‡ Review of Applied Entomology, Vol. 1, pages 395 and 493, 1913.

§ A. Barbey, Traité d'Entomologique Forestière, page 269, 1913.

‖ W. E. Collinge, A Manual of Injurious Insects, page 217, 1912.

¶ E. A. Ormerod, Manual of Injurious Insects and Methods of Prevention, page 250, 1890.

** Schoyen, T. H., Review of Applied Entomology, Vol. iv, page 503, 1916.

⊙ Ibid, Vol. iii, page 443.

△ Ibid, Vol. iv, page 3.

again, and if stripped for a few consecutive seasons, it would surely be killed. According to the published accounts, in Europe the injury seems to be confined to young trees up to twelve or fourteen years of age.

Life History and Habits.

There are two broods each year in Connecticut and the winter is passed in the cocoon on the twigs. The adults begin to emerge in April and continue through May and up to July 20. Meantime most of the first brood larvae had matured and made their cocoons by the middle of June. The second brood larvae feed during August and September.

Thus it will be seen that these broods are not well separated but overlap so that it is often difficult to distinguish them.

The larval stages, on the average, last about 30.5 days. The larvae of the first brood feed upon the old and mature leaves and leave the tender new growth untouched. This new growth becomes sufficiently mature, however, to be used as food by the second brood larvae.

In our studies, nearly all of the cocoons of both broods are fastened to the twigs, but in Europe it is said that the first brood cocoons are so placed, and those of the second brood are found upon the ground.

The larvae feed with their heads toward the tip of the needle as shown on plate VI, and when very young often three or four together surround it. When feeding in this manner they eat all of the needle, but when only one or two feed they eat along the edge of the needle, making it look as though it had been scraped. When the larvae are disturbed they throw their heads back, and from their mouths exude a drop of liquid which they absorb again.

The full grown larvae, in looking for a suitable place to spin cocoons, occasionally crawl into an empty cocoon which is still attached to the tree. Then all that is necessary is to put a new top on the old cocoon. Such a case is shown on plate IX, b.

Number of Broods.

In Connecticut there are two broods (considering a brood from adults to cocoons) and in 1915 a partial third brood was obtained. The adults emerging from the second brood cocoons in this case

emerged late in the summer and were males. The broods overlap somewhat and adults from the first brood of larvae sometimes do not emerge until the following year. It also happens that the adults from the first brood often emerge before some of the adults from over-wintering cocoons.

Adults begin to emerge from over-wintering cocoons as early as April 3 and continue to emerge until July 20, while the greatest number emerge during the last half of May. Adults from the first brood of larvae begin to emerge June 19 and continue until August 28, and in two cases the adults did not emerge until early in June of the following year.

Food Plants.

In our experiments *Diprion simile* has been reared on several species of pine. The following list is arranged according to the preference shown by the sawflies in nature and to the largest number of sawflies reaching maturity in our host plant experiments:

- *Pinus excelsa* Wall. Bhotan Pine.
- " *cembra* Linn. Stone Pine.
- " *flexilis* James. Limber Pine.
- " *strobus* Linn. White Pine.
- " *Koraiensis* Sieb. & Zucc. Korean Pine.

} 5-needled pines.

- " *montana* Du Roi. Mugho Pine.
- " *densiflora* Sieb. & Zucc. Japanese red Pine.
- " *resinosa* Ait. Red Pine.
- " *sylvestris* Linn. Scotch Pine.
- " *ponderosa* Dougl. Bull Pine.
- " *laricio* Poir. var. *Austriaca* Endl. Austrian Pine.

} 2-needled pines.

- " *rigida* Mill. Pitch Pine. 3-needled pine.

The 5-needled pines are preferred as food above other species and it is very easy to rear larvae on these kinds. The 2-needled species are attacked, especially the softer-needled kinds. Those having hard, stiff needles, like the Scotch, bull and Austrian pines, are almost immune. In the nursery no very young larvae were found on these species but nearly full grown ones were often found. Several attempts have been made to obtain adults from the egg stage on Austrian pine but all were failures. The larvae died during the first instar although many of them had started

to feed. Larvae which had passed the second moult on other pines and were then transferred to Austrian pine, lived and adults of both sexes emerged from the cocoons.

Eggs have been laid on pitch pine, but like Austrian pine, the larvae fed on the needles for about a week, but all died before the first moult. Attempts were made to obtain eggs and rear larvae on other conifers without success except that a few eggs were laid on white spruce; these hatched but the larvae did not feed.

Moults.

The larvae of this sawfly pass through five moults before they reach the pupa stage. The time between moults varies, the earlier instars from first to third are only two or three days, while the later ones are from four to seven days. The markings on the larvae do not appear distinctly until after the third moult; then they do not change in appearance except for size until they reach the prepupal stage. After this moult the larvae are much lighter in color and eye spots appear. The larvae now stop feeding and look for a suitable place to spin a cocoon, which they usually accomplish in a day or two.

1st Instar.

Larvae when just hatched have light, slate-colored bodies, head lighter, with two eye spots. After a few hours the head becomes shiny black and the eye spots disappear, thoracic legs also become black, body becomes yellowish green, semi-transparent, and the food inside the body showing darker green.

2d Instar.

Larvae look very much like those of the 1st instar except that they are a little larger. No markings are visible yet.

3d Instar.

Not much change in appearance from previous instars. Body a little darker than in 1st and 2d instars.

4th Instar.

Markings show plainly. Head and legs shiny black. There is a double black dorsal line extending the entire length of the body. On either side of the dorsal stripe there is a yellow stripe broken with transverse markings of brown. Lateral surface dark brown with many irregular yellow spots. Yellow markings protrude, making them look somewhat like blisters. Ventral surface pale yellow. Prolegs pale yellow, with transverse black marks at

base. True legs black, yellow at the joints. Body sparsely covered with minute spines; more spiny at posterior end of larva.
5th Instar.

Markings same as in 4th instar except that they are brighter, the dark portions much darker, giving the larva a somewhat darker appearance.
6th Instar (prepupal stage).

Head greenish with black eye spots. Legs light green, markings same as in other moults but colors very light, making general appearance of larva much lighter. Prolegs not very well developed in this stage and are of little use, larva falling from twigs very easily.

Larvae now spin cocoons and remain in larval stage until shortly before adults emerge, when they pupate. The pupal stage lasts only for a few days.

Description.

The appearance of this insect in all its stages is shown on plate VI, and briefly may be described as follows:

Egg. The eggs are laid end to end in slits made along one of the ridges at the edge of the needle as shown on plates VI, 2, and IX, c. The eggs are pale blue in color, smooth and slightly shining. The sides are parallel with the ends rounded. Length, 1.25 mm., thickness, .33 mm. In the material examined the newly-laid eggs were slightly separated in the slits. The eggs before hatching increase in size, becoming crowded in the slits so that the ends are flattened like peas in a pod.

Larva. Length, 25 mm. (1 inch) to 28 mm. ($1\frac{1}{8}$ inches). Thickness, 4 mm. (5/32 inch). Head black, body greenish-yellow with a mid-dorsal double stripe of brown extending the entire length. On either side of the dorsal stripe is a yellow stripe broken with transverse markings of brown. The remainder of sides dark brown with many irregular yellow or whitish spots. Ventral surface pale yellow or white. Prolegs yellow with a transverse black mark at base, true legs marked with black and yellow. Shown on plate VIII, b.

Cocoon.—9 mm. long (about 3/8 inch), thickness about 5 mm., oval in shape, tough, leathery and fairly smooth. Color, sepia. See plate VIII, c.

Male. Wing-spread, 14 mm. (9/16 inch). Length, 7 mm. Large pectinate antennae. Head and pronotum coarsely punctured. Head, antennae and body, black. Cerci and tip of the last abdominal segment, orange. Legs yellow, with the trochanters and basal two-thirds of the femora, brownish black. Shown at the right on plate VI, 1.

Female. Wing-spread, 20 mm. (little over 3/4 inch). Length, 8 mm. (5/16 inch). Robust, head and antennae black. Thorax coarsely punctured, yellow with a large shield-shaped black spot on mesothorax, extending from the anterior margin and covering about two-thirds of the space between the parapsidal grooves. On either side are a pair of L-shaped black marks which approach each other posteriorly. Posterior margin of the mesothorax, postscutellum and prosternum, black. Abdomen yellow with dorsal surface of 3d, 4th, 5th, 6th and the anterior portion of 7th segment, black. Legs yellow with the outer surface of hind femora, the apex of the middle and hind tarsi, dark. Shown at the left on plate VI, 1.

Egg-Laying Habits of the Female.

On emerging from the cocoons in the breeding cages, the females begin to run aimlessly about, going all over the pine twigs for a period which is more or less indefinite but which usually averages about twenty-four hours. They then commence to deposit eggs. In ovipositing the female places herself on the pine needle facing its tip, and grasps it firmly with her tarsi, the hind legs extending slightly beyond the abdomen. The ovipositor is then inserted in the edge of the needle and a slit is cut in it, working from the base toward the tip. When this incision has reached a length of about one-tenth of an inch, the sawfly rests for a few seconds, then lays an egg placed horizontally in the slit, gradually drawing the ovipositor backward and out of the needle. This withdrawing of the ovipositor partially covers the egg with resin and sawed pulp from the leaf. She then moves forward and proceeds to cut a slit in which the next egg is placed. The eggs are thus placed end to end in the incision, as many as twenty sometimes being placed in line in the needle as shown on plate IX, c. The time required to lay a single egg is about four minutes in *Pinus excelsa* and about five minutes in *Pinus densiflora*.

The females usually begin to lay eggs in about a day after emerging from the cocoons, and live for about seven days, while those individuals (about eleven per cent.) which do not oviposit die in four or five days. With the males the length of life varies; some individuals live longer than the females, and some do not.

The eggs are usually laid in needles of the previous season's growth, if such are present. Most of the eggs for the first brood hatch during the first half of May, and those for the second brood early in August, though the broods overlap, and it sometimes happens that some of the first brood females are so late in emerging from their cocoons that their eggs do not produce larvae until after some of the second brood eggs have hatched.

Number of Eggs Laid.

Upon dissecting the bodies of females from over-wintering cocoons, an average of 58 eggs was found in each. The number of eggs in a female of the first brood averaged 76, while those of the second brood averaged 74. The largest number of eggs recorded as having been laid by one female was 128; this is more than we ever dissected from the body of any female sawfly. The average number of eggs laid was 64.

Parthenogenesis.

In our studies of this insect, copulation has been observed only once, but eggs are laid which develop and hatch if males are not present. Moreover, the presence or absence of males has no apparent effect on the number of eggs laid. Some females oviposit when males are present and others do not. The only time copulation was observed, the pair of adults were transferred to a breeding cage to obtain eggs and larvae. The female died in a few days and upon examining the cage no eggs were found.

In thirteen cases the adults reared from eggs laid by virgin females were all males. Out in the field under natural conditions the number of females emerging from over-wintering cocoons was slightly greater than that of males. Out of 1,675 adults from over-wintering cocoons, 912 were females and 763 were males. During the summer of 1917 a freak adult or gynandro-

morph emerged from some cocoons collected in the field. It has one female antenna and the other is that of a male sawfly. The left side, including antenna and markings on thorax, is that of a female, while the right side has a male antenna and the thorax is without markings—just black like the males. The abdomen is darker than that of a female, yet lighter than that of a male. It also has the characteristic female ovipositor. The specimen was killed in a cyanide tube before we discovered that it was a freak. This specimen is shown on plate IX, d.

Parasites.

About twenty-eight per cent. of the cocoons of *Diprion simile* collected during the winters of 1915–16 and 1916–17 showed the exit holes of parasites. Following is a list of the nine specie reared, arranged in the order of their abundance:

Hymenoptera.

Dibrachys nigrocyaneus Norton (*Pachyneuron*), *Monodontomerus dentipes* Boheman, *Dibrachoides verditer* Norton (*Pteromalus*), *Delomerista* n. sp., *Cerambycobius* sp. (probably new), *Eurytoma* sp., *Hemiteles utilis* Norton.

Diptera.

Exorista petiolata Coquillett.

Of these nine species of parasites only the first three were reared in sufficient numbers to indicate that they are at all effective in holding the pest in check, and of the three, *Dibrachys nigrocyaneus* Norton was by far the most abundant.

During the winter of 1916–17, 3,240 cocoons were collected. Of these, adults emerged from 41 per cent., 37 per cent. were parasitized, and 6 per cent. were torn open by birds, mice or squirrels, and the pupae eaten. The remaining 16 per cent. produced no living insects, but when the cocoons were opened a large number of them contained dipterous pupae; in some of these the adult flies had broken off the ends of their pupa cases preparatory to emerging. See plate IX e. Tachinid eggs were found on many of the *Diprion* larvae in the field, but only one fly (*Exorista petiolata* Coquillett) has been reared. Apparently all of the others have been unable to escape from the tough *Diprion simile* cocoons. The cocoons of our native species are not as tough as those of *D. simile*.

The figures and percentages mentioned in the preceding paragraph are shown in the following table:

Cocoons Collected During Winter 1916–1917.

	Number	Percentage
Adult sawflies emerged	1,321	41
Parasites emerged	1,210	37
Torn open and eaten	191	6
Dead	518	16
Total	3,240	100

In the field many dead larvae were found on the trees suspended by their prolegs, having been killed by a wilt disease. This disease seems to be the most prevalent late in the season, and is effective in killing the larvae of the second brood. It also seems to be more prevalent on trees which have been stripped, though possibly it is because they are more conspicuous on such trees.

In regard to the insect parasites listed above, all those specifically identified are native species with the exception of *Monodontomerus dentipes* Boh., which is a European species which had been found previously in the United States. *Dibrachoides verditer* Norton and *Dibrachys nigrocyaneus* Norton were originally described from Connecticut.

Probably Introduced on Nursery Stock.

The most plausible theory is that this sawfly was brought into this country on nursery stock. A few cocoons attached to the leaf-covered twigs might easily escape notice by the inspector in examining the imported stock, especially before its presence in this country was discovered. Cocoons might also occur in the ball of earth on the roots, as it is seldom possible with the help and funds available in Connecticut to examine carefully the soil about the roots. Empty sawfly cocoons have been found in cases of azaleas from Belgium.

Since 1909, when nests of the brown-tail moth were found on nursery stock coming into this country from Europe, an attempt has been made to inspect all shipments of field-grown woody plants coming into Connecticut from all foreign countries. At first it was impossible to trace all shipments and we were obliged to depend chiefly upon information furnished us by the nurserymen. Most of the importations arriving at the principal nurseries were

inspected but florists and private owners also made importations and there were unquestionably a number of shipments each year which were not examined. On the establishment of the Federal Horticultural Board in 1912, the system of permits and notices has enabled us to trace each shipment and practically all such stock has been examined. But there were probably many shipments brought into the State prior to 1909, and these were not inspected at all. On account of the blister rust diseases and the pine shoot moth, all pines are now prohibited from entering the United States from Europe.

Since the establishment of the Federal Horticultural Board and the present system of inspecting imported nursery stock, sawfly material has been intercepted at least eleven times, as follows:

Sawfly	Host	Source	Destination
Cocoon.....	Fruit trees.....	England.....	New Jersey
Larva.....	Box.....	Holland.....	Indiana
Diprion pini....	Mugho pine.....	"	Massachusetts
Cocoon.....	Spruce.....	"	Nebraska
"	Azalea.....	Japan.....	New Jersey
" (empty)	" .....Belgium.....		Connecticut
Diprion simile..	?	Holland.....	Indiana
Cocoon.....	Quince.....	France.....	Nebraska

It will probably never be known just how, when or where this insect was first brought into the United States. Possibly it was first introduced into the very nursery where it was first discovered, though other nurserymen in Connecticut and hundreds of them in other states have imported pines from Europe, and the insect might have come in any of these shipments.

Danger to the Pine-Growing Industry in the United States.

It is impossible to foretell how serious a pest this sawfly may become in the United States. Any introduced insect which feeds upon an important crop is dangerous; doubly so if its natural enemies are left behind. As the food plants of *Diprion simile* are fairly abundant in this part of the country, and the climate seems to be favorable, it is probable a question of parasites and other natural enemies that will determine its status as a pest here. It is encouraging that our native species parasitize it so freely.

Control Measures.

In each infested nursery in Connecticut, the owner has been required to spray the pines with lead arsenate (3 lbs. in 50 gallons of water) late in summer when the second brood of larvae were feeding. Later, after all larvae had transformed, a careful inspection was made of each tree and all cocoons removed. These measures appeared to be necessary in order to reduce to the minimum the danger of further distributing this pest on nursery stock. A similar spraying early in May would forestall injury by the first brood of larvae.

Ornamental trees and small plantings on private grounds can likewise be sprayed, but the cost would be prohibitive in large forest areas.

In Europe it is recommended that the leaves and other rubbish be gathered and burned late in fall in order to destroy the cocoons, but this method can hardly be advised in this country, as all the cocoons are fastened to the twigs. Some cocoons were found upon the ground during the winter and spring, but these had probably been torn off by snow or ice storms, or possibly by birds.

In Russia, V. G. Averin* recommends as control measures that larvae be shaken into pails, crushed on the branches with leather gloves, and that the trees be sprayed with barium chloride (5 lbs. in 27 gallons water) and with Paris green.

In Germany,† outbreaks were checked by collecting the larvae and by spraying with petroleum soap emulsion. It is said that on an estate of about 150 acres near Danzig in 1905, the pines were cleared of 1,412 litres (5,600,000 individuals) of larvae at a cost of about $50.00. The following year (1906) about half of this area or 75 acres were cleared of 201 litres (800,000 individuals) at a cost of about $7.00.

Acknowledgment.

The writers herewith express their indebtedness and thanks to Mr. S. A. Rohwer of the Bureau of Entomology, Washington, D. C., who has identified specimens, furnished references and examined the manuscript of this bulletin.

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* Journal of Applied Entomology, Vol. iii, p. 106, 1915.

† Ibid, vol. iii, page 3, 1915.

Summary.

Diprion simile, a dangerous European sawfly, has been brought into the United States, probably on nursery stock. It was first discovered in Connecticut in 1914, but has since been found in New Jersey and New York, having apparently become established in these three states independently. It has also been found on imports entering Massachusetts and Pennsylvania.

In Europe this sawfly has been associated with *Diprion pini* in many serious outbreaks, notably in Russia, Germany, France, Norway, Sweden and England.

The larvae injure pine trees by feeding upon the leaves of several species, preferring the five-needled pines. There are two generations in Connecticut, and possibly a partial third generation in favorable seasons.

This insect passes the winter in the cocoon stage on the twigs and the adults begin to emerge the latter part of April. Egg-laying soon begins in the needles of the previous season's growth. The first brood larvae feed during May and early June, and the second brood larvae feed during August and September. Each female lays, on the average, 64 eggs. The first brood larvae feed on the old needles rather than the new tender growth, but this new growth becomes sufficiently mature to serve as food for the second brood larvae. Thus trees may be stripped in one season.

The larva moults five times before reaching the pupa stage, and when fully grown is about an inch long, with body greenish-yellow, with a double brownish stripe extending along the back. On each side of this stripe is a yellow stripe crossed by narrow brown markings. Head black.

The adults are robust, with transverse clouded areas on the wings. The female has slender antennae, and thorax and abdomen are yellow with black markings; the male has broad, pectinate antennae and is nearly all black.

Apparently this sawfly is parthenogenetic, for without the intervention of males, eggs are laid which hatch and develop normally.

The cocoons are strongly parasitized, nearly 50 per cent. being killed. Eight species of hymenopterous parasites and one dipterous parasite have been reared. Three of the former, *Dibrachys nigrocyaneus*, *Monodontomerus dentipes* and *Dibrachoides verditer*, bid

fair to become effective in checking the pest. Of these, the first is by far the most abundant. The first and third are native American insects, and the second is a European species which has previously been recorded from the United States.

Whether or not this sawfly seriously injures the pine growing industry in this country probably depends on its parasites.

Spraying the pines with lead arsenate early in May, and again in August, and destroying the larvae and cocoons when found, are the control measures to be practiced.

This insect in its various stages is shown on plates VI-IX.

Literature.

Averin, V. G. (Entomological and Phytopathological Bureau of the Temstvo of Charkov, Russia, Bull. 3, 1913). Review of Applied Entomology, Vol. i, p. 493, 1913. (Mentions *pini* as attacking pines.)

(Bulletin on Pests of Agriculture and Methods of Fighting Them. No. 5, Charkov, Russia, 1914.) Review of Applied Entomology, Vol. iii, p. 67, 1915. (Mentions *pini* larvae as injuring pines.)

(Information on the Appearance and Activity of Insect Pests during April and May.) Review of Applied Entomology, Vol. iii, p. 106, 1915. (Brief mention of injury of *pini*, with remedies.)

Review of the Pests Noticed in the Government of Chartov during 1913.) Review of Applied Entomology, Vol. iii, p. 401, 1915. (Brief mention of injury caused by *pini* with remedies.)

(Review of Pests Noticed in 1914 and the Possibility of their Appearance in 1915.) Review of Applied Entomology, Vol. iii, p. 443. (Mention of injury caused by *pini*.)

Baer, W. *Lophyrus similis* Hart. Naturwissenschaftliche Zeitschrift für Land-und Forstwissenschaft. Vol. 4, H. 2, p. 84, 10 fig., 1906. (Notes on *similis*.)

The Sawflies of Coniferae. Naturwissenschaftliche Zeitschrift für Land und Forstwissenschaft. Vol. xiv, pp. 307–325, 1916. Review of Applied Entomology, Vol. v, p. 57, 1917. (Mentions *simile* as attacking Weymouth pine in Germany.)

Barbey, A. Traitè d'Entomologie Forestière, p. 265, 1913. (Gives an account of *pini* with mention of *similis*.)

Britton, W. E. A Destructive Pine Sawfly Introduced from Europe. Journal of Economic Entomology, Vol. 8, p. 379, 1915. (First account of the appearance of *Diprion simile* in the United States in Connecticut. Descriptions and illustrations.) Abstracted in Journal of Applied Entomology, Vol. iii, p. 573.

A Dangerous Pine Sawfly. Tree Talk, Vol. 3, p. 45, 1915. (Brief account of *simile* with figure of larvae.)

A Destructive European Pine Sawfly in Connecticut. Report Connecticut Agricultural Experiment Station, p. 118, 1915. (Full illustrated account.) Abstracted in Journal of Applied Entomology, Vol. iv, p. 242, 1916.

Further Notes on *Diprion simile* Hartig. Journal of Economic Entomology, Vol. 9, p. 281, April, 1916. (Brief notes on life history, food plants and parasites.) Abstracted in Journal of Applied Entomology, Vol. iv, p. 286, 1916.

Buttrick, P. L. Another Insect Enemy of the White Pine. American Forestry, Vol. xxii, p. 395, July, 1916. (Brief illustrated article from Reports of this Station.) Mentioned in Review of Applied Entomology, Vol. iv, p. 419.

Collinge, W. E. A Manual of Injurious Insects, p. 217, 1912. (Brief account of *pini*.)

Eckstein, K. Forstliche Zoologie, pp. 461–463, 1897. (Brief descriptions of *pini* and *similis*.)

Enslin, E. The European Species of *Diprion*. Naturwissenschaftliche Zeitschrift für Forst-und Landwirtschaft, Vol. xiv, p. 1, 1916. Journal of Applied Entomology, Vol. v, p. 55, 1917. (Systematic paper with keys to adults.)

The Tenthredinoidea of Central Europe. Deutsche Entomologische Zeitschrift. (Supplement) 1912. (Morphology of larvae.)

Die Blatt-und Holzwespen. Die Insekten Mitteleuropas, insbesondere Deutschlands. Bd. iii, 1914. (Keys to larvae.)

Forsius, R. Medd. Soc. Fauna Flora Fennica, Vol. 13, p. 183, 1911. (Records *similis* as occurring in Finland in 1910.)

Gillanders, A. T. Forest Entomology, p. 175, 1908. (Illustrated account of *pini*.)

Hartig, T. Forstliches Convers.,—Lexicon 2, Aufl. p. 987, 1834. (Original account of *similis*.)

Die Familien der Blattwespen und Holzwespen, p. 160, Pl. iii, fig. 9, 1860. (Original description of *similis* and short account of life history and presence around Berlin and Stettin.)

Henry, E. Atlas d'Entomologie Forestière, Plate xxii, fig. 1, 1903. (Illustrations of *pini*.)

Howard, L. O. Report of the Entomologist. Annual Report U. S. Department of Agriculture, year ending June 30, 1916, p. 228. (Mention.)

Judeich and Nitsche. Lehrbuch de Mitteleuropäischen Forstinsektenkunde, p. 635, 1895. (Treats of *similis* and *pini* with several other species, and gives a key for the separation of their larvae.)

Kaltenbach, J. H. Die Pflanzenfeinde, p. 700, 1874. (Mentions both *pini* and *similis*.)

K. T. (Pests in the Forests of the Government of Tambov, Russia, No. 7, p. 25, 1913.) Review of Applied Entomology, Vol. ii, Series A, p. 13, 1914. (Mention of *pini*.)

(Pests in the Forests of the Government of Tambov, Russia, No. 6, 1914.) Review of Applied Entomology, Vol. ii, Series A, p. 332, 1914. (Mention of *pini*.)

Kolossov, J. M. (Review of the Pests of Field Crops and Forests of the Ural.) Review of Applied Entomology, Vol. iii, p. 398, 1915. (Brief mention of *pini*.)

Ksenjopolsky, A. V. (Review of the Pests in Volhynia.) Review of Applied Entomology, Vol. iii, p. 606, 1915. (Mention of *pini*.)

Nikolaev, P. (Journal of Agricultural Society of Poltava, Russia, p. 676, 1913.) Review of Applied Entomology, Vol. i, Series A, p. 395, 1913. (Injury by *pini*.)

Ormerod, E. A. Manual of Injurious Insects and Methods of Prevention, p. 250, 1890. (Account of *pini*, with preventive measures.)

Reh, L. Sorauer's Handbuch der Pflanzenkrankheiten, Die tierischen Feinde, Dritter Band, p. 598, 1913. (Gives *similis* as a synonym of *pini*.)

Rohwer, S. A. *Diprion simile* in North America. Proceedings Entomological Society of Washington, Vol. xviii, p. 213, 1916. (Brief article giving identity, distribution, and first record from New York.)

Schoyen, T. H. (Injurious Insects and Fungi of Forest Trees in 1914.) Review of Applied Entomology, Vol. iv, p. 503, 1916. (Damage by *pini* in Norway.)

Weiss, H. B. Journal of Economic Entomology, Vol. 10, p. 224, 1917. (Record of occurrence in New Jersey.)

Journal New York Entomological Society, Vol. xxiv, p. 313, 1916. (Brief mention.)

Zappe, M. P. Egg-Laying Habits of *Diprion simile* Hartig. Journal of Economic Entomology, Vol. 10, p. 188, 1917. (Records of egg-laying habits, parthenogenesis, and food plants.)

———— (Campaign against Insect Pests in the Forests of the Government of Tambov in 1914.) Review of Applied Entomology, Vol. iii, p. 728. (Mentions *pini* and an undetermined insect which infested young pines up to twelve years old.)

The same for 1915. Review of Applied Entomology, Vol. iv, p. 497. (Gives an account of handpicking 460,000 larvae of *pini*.)

———— (Deutsche Landwirtschaftliche Presse, Vol. xlii, p. 761.) Journal of Applied Entomology, Vol. iv, p. 3, 1916. (Mentions damage caused by *pini* in Brandenburg and Silesia.)

OUTBREAK OF THE PINK AND GREEN POTATO APHID, *Macrosiphum solanifolii* Ashmead.

By W. E. Britton and Q. S. Lowry.

On July 9th, while the entomologist was absent on a vacation, several inquiries were received at the office about aphids on potatoes. The Frank S. Platt Company of New Haven telephoned that it had received complaints from all over the State, and asked for a remedy. Nicotine solution was advised. For a period of about two weeks there were many inquiries by telephone and by mail from various parts of the State, but chiefly from Hartford,

Waterbury, New Haven and the regions surrounding these cities, and Mr. Lowry was kept busy answering them.

There was such a demand for information, and prompt action being necessary, that the Director, after conferring with the assistant entomologists, prepared the following press notice, which appeared in the daily papers of July 16th:

"Danger from the Potato Aphid.

An aphid or plant louse is very abundant on potato vines now and threatens very extensive damage to the crop.

Control by spraying now is very difficult because of the heavy growth of vines and the fact that the lice are abundant on the lower surface of the leaves.

Spraying the upper surface alone is not effective. The best remedy that we can recommend is a nicotine spray with soap solution made as follows:

One-half pint 'Black Leaf 40' and two pounds whale oil soap or yellow soap dissolved in a barrel of water. For use on a small scale dissolve one to one and one-half teaspoonfuls of 'Black Leaf 40' in a gallon of water, with a piece of soap about an inch square. Any other tobacco preparation may be substituted which carries as much nicotine as the one named above. The full amount given in the manufacturer's directions should be used. To be effective the spray must cover not only the upper surface but the under side of the leaves as well, and also the tender stems, therefore the spray must be directed in part from beneath upward. This spray containing soap cannot be applied with Bordeaux mixture but may follow or precede it by a few days."

Infested potato fields were reported from every county in the State and from the following localities:

Fairfield County—South Norwalk (turnip), Redding.

New Haven County—New Haven, Westville, North Haven, Montowese, West Haven, Mount Carmel, Cheshire, Branford, North Branford, Meriden, Middlebury, South Britain, Naugatuck, Waterbury.

Middlesex County—Middletown.

New London County—New London.

Litchfield County—Harwinton, Thomaston.

Hartford County—Hartford, East Hartford, Thompsonville, Wethersfield, Farmington, New Britain, Plainville, Bristol.

Tolland County—Bolton.

Windham County—Killingly.

It was doubtless present in many other localities, though not reported to the Station.

In 1903 this aphid was abundant on potatoes in Fairfield, and in 1909 it was found on potatoes in the Station garden by Mr. Arthur I. Bourne, then an assistant in this department. On July 18, 1912, it was received on both potato and corn from Mr. Noyes Palmer of Stonington, and on potato from Mr. Alfred L. Beebe of Mystic. These last-mentioned infestations were apparently local, and no great or widespread damage was reported.

Prior Connecticut Records of this Species.

The aphid material in the Station collection was determined chiefly by Dr. Edith M. Patch of the Maine Agricultural Experiment Station, Orono, Me., and contains several microscope slides of *Macrosiphum solanifolii* Ashm. From these the following data are taken:

Host	Locality	Date	Collector
Potato	Mystic	18 July, 1912	A. L. Beebe.
Tobacco	So. Glastonbury	27 July, 1904	W. E. Britton.
	New Haven	22 July, 1909	A. I. Bourne.
Ground Cherry (*Physalis pubescens*)			
	Meriden	21 Sept., 1908	W. E. Britton.
Jerusalem Cherry (*Solanum pseudocapsicum*)			
	New Haven	27 July, 1909	A. I. Bourne.
Squash	New Haven	21 July, 1909	A. I. Bourne.
		8 July, 1914	M. P. Zappe.
Beet	New Haven	30 July, 1909	A. I. Bourne.
	Milford	19 July, 1915	W. E. Britton.
Lettuce	New Haven	22 July, 1909	A. I. Bourne.
Milkweed (*Asclepias* sp.)			
	New Haven	29 June, 1916	B. H. Walden.
Clematis crispa	New Haven	18 June, 1901	W. E. Britton.
Bitter Sweet (*Celastrus scandens*)			
	Windsor	19 June, 1912	Mrs. Mary Allen.

Distribution in the United States.

This aphid was first described from Florida by Ashmead in 1882, on wild pepper vine, *Solanum jasminoides*. As it has also been recorded from Maine, Canada, California, and a number of the states between, it is fair to assume that it may occur throughout the United States.

Davis,* writing in 1904, states: "Although not commonly and generally a pest of the potato in Illinois, I have occasionally found it exceptionally and injuriously abundant."

* Jour. Econ. Ent. Vol. 4, page 330, 1904.

In 1904, 1905 and 1906, this insect was prevalent in Aroostook County, Maine, and caused much damage to the potato crop.

Certain potato fields in Iowa** were infested in 1912, but natural enemies promptly checked the outbreak before much damage was done.

According to available reports, aphids were prevalent on potatoes in 1917, in Illinois, Indiana, Missouri, Kentucky, Ohio, Pennsylvania, Maryland, Virginia, District of Columbia, New Jersey, New York and Massachusetts, as well as in Connecticut. Possibly in some cases the damage was done by another species, known as the green peach aphid, or spinach aphid, *Myzus persicae Sulz.*, which is common everywhere, and which seemed to be the chief species on potatoes in some of the southernmost states named above. This aphid may attack almost any kind of vegetable crops.

Injury.

The aphids caused the leaves to curl and the plant to assume the appearance shown on plate X, a. The leaves soon turned brown on the edges and the vines were soon killed. Apparently this infestation seriously checked the crop; the tubers were arrested in their development and a very small yield resulted. In a field at the Station farm at Mt. Carmel, the vines were large and vigorous and promised a good crop; but this field was heavily infested with aphids in July, and though sprayed and most of the aphids killed, the plants did not recover and died in a few days. The yield was very small, some portions of the field being hardly worth digging. Plate XI,b, shows a field where the vines have been killed by aphids.

On the other hand, Mr. A. N. Farnham of New Haven raised one of the best crops of potatoes in 1917 that he has ever grown. He planted early varieties as soon as the ground could be worked and matured the crop before the aphids came. One field at the Station farm gave a fair yield, but this was an early variety planted late, and was not attacked by aphids.

The aphids are usually on the under side of the leaves and on the tender shoots of the potato. The following account of injury is taken from Bulletin 317, Ohio Agricultural Experiment Station, page 69:

** Bull. 155, Iowa Agr. Expt. Sta., page 400, 1915.

"The tender leaves on the tip of the plant are first to be attacked; and as the leaf develops and the lice continue their sap-sucking, devitalizing work, the edges turn downward and after a short time the whole structure takes on the distorted, contracted aspect so characteristic of the work of many aphids.

"In the later stages, the plant dies from the top downward. It is difficult to determine the actual damage the insect inflicts in cases where the plant is not killed outright. Unquestionably the production of tubers is minimized when the leaves of the top become badly curled; indeed, the curtailment may be considerably greater than is realized. In addition to the primary harm inflicted, we must attribute a part of the damage caused by plant diseases directly to the aphids, since on account of their well-known migrating habits they unquestionably are a factor in disease dissemination."

On tomato in Ohio no fields or plants were killed outright, though the aphids, as on potato, attack the tender shoots and leaves and cause the leaves to curl. A favorite place is on the blossom clusters, and they cause the blossoms to fall without the fruit setting, thus greatly reducing the yield. On egg-plant and pepper the greatest injury, as on tomato, resulted from a failure to set fruit on account of the stems being devitalized by the attacks of the aphids.

Dr. Felt estimates that on Long Island and in the southern part of New York state, where the aphid attacks were the most severe, at least one-fourth of the potato fields were very seriously damaged, and the vines killed.

Habits and Life History.

This aphid passes the winter in the form of a shining, oval, black egg, which, according to Dr. Patch, occurs more often upon the rose than any other plant. On the approach of warm weather in spring these eggs hatch into agamic viviparous females, which are usually found on the new rose shoots and especially around the flower buds in early summer. Some of these females acquire wings and fly to the potato fields; the wingless forms travel by walking if a potato patch is sufficiently near. Thus usually by July 1st the aphids have become colonized on potato and only a few stragglers are left upon rose.

According to Dr. Patch, a female may produce 50 or more young in two weeks, and in warm weather these may become mature in two weeks and in turn begin to produce living young.

On the potato the aphids seem to find favorable conditions for growth and development and increase at an enormous rate. In Ohio only ten days are required for the young to reach maturity; hence several generations are possible during the summer breeding season. Finally a true sexual generation is developed in the fall, consisting of winged males and wingless females, the latter laying eggs on the rose or other host to carry the species through the winter. In Ohio, studies were made on the rate of reproduction. One female was caged on a plant which had been freed from its entire aphid population, and at the end of two weeks the colony consisted of 76 aphids, five of which were producing young. Counts were made of the aphids on three tomato plants: No. 1, a small one having seven leaves, had 1237 aphids; No. 2, a large branching plant with 12 stalks, had 34,688 aphids; No. 3, also a large spreading plant, had 25,750 aphids. Plate X, a, shows a tomato shoot infested with aphids.

Both Dr. Patch in Maine and Mr. Houser in Ohio noticed the strong tendency of the winged forms to drop to the ground when the host plant is disturbed.

Host Plants.

Besides attacking potato, this aphid injures tomato and egg-plant, and is found on many other hosts. In Ohio in 1917*, potatoes, tomatoes, egg-plants and peppers were attacked and severely injured. In Connecticut, we have only one report to show that it infested tomato, one on turnip, and none to show that it caused injury to plants other than potato in 1917. A list of the known host plants follows: Potato, tomato, egg-plant, pepper, pea, sunflower, rag-weed, jimson weed, lambs quarters, sweet potato, turnip, ground cherry (*Physalis*), shepherd's purse, canna, hollyhock, matrimony vine, corn, beans, plantain, moth mullein, smartweed, curly dock, catalpa, pokeberry, iris, gladiolus, red-root pigweed, apple, pepper-vine, aster, cineraria, buckwheat, rose and lettuce.

In 1912, this insect was received on corn and potatoes from Stonington, the potato leaves being badly infested.

Description.

The appearance of the winged viviparous female is shown in figure 3.

*Bull. 317, Ohio Agr. Expt. Station, November, 1917.

Figure 3. The potato aphid, winged female, summer form. Greatly enlarged.

The following description was published by Dr. Patch in Bulletin 242, of the Maine Agricultural Experiment Station, page 208:

"In general *Macrosiphum solanifolii* is a large species either green or pink. The apterous forms are somewhat inclined to drop from the plant when disturbed. The abdomen is not marked with dark, but is ordinarily clear in color either pink or green, though sometimes late in the season individuals may be found with a mottling part pink and part green. The mature forms are rather glistening, but in the stage previous to the last molt the insect usually has a mid-dorsal line of dark green or pink (according to the color of the individual) while the rest of the dorsum is paler by virtue of a very slight powdery deposit. This appearance is more noticeable in bright light. The beak is short, usually, not or barely reaching the second coxa, though certain collections have been taken with beaks a little longer. The cornicles are characterized by reticulations at the tip. This reticulation holds true for all the mature individuals—alate and apterous viviparous females, oviparous females, and males—whether of the green or pink variety, and regardless of the food plant upon which they have developed. The cornicles of the immature individuals are not so marked. The antennae of the apterous

females are a little swollen at the proximal part of III. where a few sensoria are placed; those of the alate females have the sensoria in a single row not extending to the distal tip of III. The wing veins are clear cut and well defined though slender.

" The foregoing are the general recognition marks. There is no structural difference between the spring and the fall individuals great enough to lead one to think they might be different species; though there is a range in size, influenced by food plant or other conditions, great enough to cause hesitation in determining certain collections unless the progenitors are known. The measurements, therefore, in the following descriptions can only be taken as approximate.

" *Winged viviparous female, green variety.* Head yellowish green. Beak typically barely reaching second coxa, though in some collections a little longer. Antennae, proximal segments pale green, distal segments dark; length of segments: III, .88 to .96 mm.; IV, .76 to .9 mm.; V, .64 to .72 mm.; VI, base .16 to .2 mm.; VI, spur .96 to 1.12 mm.; total length I to VI, 3.6 to 4.05 mm. III with single row of sensoria somewhat irregular in size numbering 18 or a few more or less, not extending to distal end. Prothorax and thorax light yellowish green, lobes brownish. Wings hyaline, veins dark brown, very slender and clear cut, stigma pale brown. Total wing expansion 8.1 mm. Legs with proximal part of femora and tibiae pale, tarsi and distal part of femora and tibiae dark. Tarsi .16 to .2 mm. Abdomen light green unmarked dorsally or ventrally. Cornicles, with proximal portion green and distal portion dark brown, imbricated for more than three-fourths its length but strongly reticulated at tip, cylindrical, length .95 mm. or about five times length of tarsus. Cauda light green, ensiform, length .48 mm. or about one-half length of cornicles. Total length of body to distal tip of cauda and exclusive of antennae 2.9 to 3.37 mm.

" *Winged viviparous female, pink variety.* Head light yellowish. Antennae with I and II light yellowish, rest dark. Sensoria as with the green variety. Prothorax and thorax light yellowish pink. Abdomen pale pink. Cornicles light yellow with tips dusky and strongly reticulated. Cauda pink. Measurements the same as with the green variety.

" *Wingless viviparous female.* Color either pink or green as with the winged viviparous form. Antennae, length of segments: III, .8 to .96 mm.; IV, .72 to .88 mm.; V, .56 to .72 mm.; VI, base .16 to .2 mm.; VI, spur .96 to 1.2 mm.; total length of segments I to VI, average about 4.05 mm. III slightly swollen at basal third where 1 to 5 sensoria occur. Cornicles .96 to 1.04 mm. in length, and strongly reticulated at tip about one-fifth the distance. Cauda .56 mm. Total length of body to distal tip of cauda exclusive of antennae, 4.05 mm.

" *Wingless oviparous female.* Head pale, nearly white. Antennae with proximal joints pale, distal half dark. Length of segments: III, .68 to .88 mm.; IV, .56 to .68 mm.; V, .52 to .64 mm.; VI, base .16 mm.; VI, spur .96 to 1.04 mm.; total antennal length I to VI average about 3.6 mm. Legs with femora and tibiae, proximal portion pale, distal

portion dusky. Tarsi dark, .16 mm. long. Hind tibiae conspicuously darker and much swollen and thickly set with sensoria. Abdomen light salmon pink. Cornicles pale at base, distal half dark and reticulated at tip; length .6 to .8 mm. Cauda salmon pink, ensiform, length .32 to .4 mm. Total body length to tip of cauda, antennae excluded, 2.13 to 2.15 mm. The size of the hind tibiae of this form makes it readily distinguished from the apterous viviparous form and young, even to the unaided eye.

"The pink variety has been described because these predominate among the oviparous females. The color scheme of the green and yellow forms can be determined merely by substituting these colors for the salmon pink of the individual described, the dark coloration being the same for all three.

"*Winged male.* Head and antennae dark brown. Length of antennal segments: III, .72 to .8 mm.; IV, .48 to .64 mm.; V, .48 to .6 mm.; VI, base .16 mm.; VI, spur 1.04 to 1.28 mm.; total antennal length I to VI, 2.93 to 3.60 mm. Sensoria numerous on III, usually none on IV, and an irregular row of them nearly the whole length of V. Prothorax and thorax dark brown. Wings hyaline, veins dark and very slender, stigma pale brown. Legs brown, darker at tips. Abdomen greenish or brown. Cornicles pale brown, dark distally and reticulated, cylindrical, .48 to .56 mm. long. Total body length exclusive of antennae and cornicles, 1.12 to 1.57 mm. The thorax is large and strong, the abdomen much shrunken, making the cornicles seem conspicuously long. The male is described from individuals taken in copulation, in order that no mistake as to the identity of the species might occur."

Parasites and Natural Enemies.

Nearly all aphids are preyed upon by adults and larvae of lady beetles, and by the larvae of lace-wing flies and syrphid flies, and these were all observed in connection with aphids on potato in Connecticut, though we did not have time to study them and to rear and identify the species. A lace-wing larva, a lady-beetle larva, and a syrphid larva are shown on plate XI, a.

In Ohio the following nine species of adult lady-beetles were observed feeding upon the aphids:* The two-spotted lady-beetle, *Adalia bipunctata*, the nine-spotted lady-beetle, *Coccinella novemnotata* (ix-*notata*), the red lady-beetle, *Cycloneda munda* (usually listed as *Coccinella sanguinea*, a tropical species), the convergent-lady-beetle, *Hippodamia convergens*, the glacial lady-beetle, *H. glacialis*, the parenthesis lady-beetle, *H. parenthesis*, the thirteen-spotted lady-beetle, *H.* xiii-*punctata*, the spotted lady-beetle, *Megilla fuscilabris* (usually listed as *maculata*, a tropical

* Bull. 317, Ohio Agr. Expt. Station, page 78, November, 1917.

species) and *Brachyacantha ursina*. The most common species were *Hippodamia convergens* and *Coccinella novemnotata*. An adult of the latter was observed to eat six aphids in 22 minutes, and a larva ate three aphids in 12 minutes.

The larva of a species of *Chrysopa* or lace-wing fly, though present and feeding upon the aphids, was not sufficiently abundant to be an important factor in checking the pest.

Three species of syrphid flies, *Syrphus americana*, *Sphaerophoria cylindrica* and *Allograpta obliqua*, in the larval stage fed upon the aphids.

The above mentioned lady-beetles, lace-wing fly and syrphid fly larvae are predaceous and devour the aphids in large numbers. There are also the four-winged or hymenopterous parasites, of which four species were very abundant in Ohio, namely, *Aphidius polygonaphis*, *Pachyneuron aphidivorum*, and two species of *Lygocerus*, the first being the most abundant. These are internal parasites, and are very effective in keeping aphids in check. When parasitized by them, the aphids become swollen, turn brown and remain fastened to the leaves. Such parasitized aphids were noticed on some of the potato leaves brought to the Station. These or similar natural enemies have been observed in Maine and Iowa attacking potato aphids.

Mr. Zappe collected some parasitized aphids on potatoes in Stratford, July 23, 1917. On July 26 and 30 some small ichneumon or four-winged flies emerged from them. These parasites were sent to the Bureau of Entomology, and through the kindness of Dr. L. O. Howard were identified by Mr. A. B. Gahan. All proved to be *Aphidius rosae* Halliday, a species which has several times been collected or reared within the State.

All of the lady beetles, the syrphid flies and the lace-wing mentioned above are common species in Connecticut. Though the four-winged flies found in Ohio have not so far been recorded from Connecticut, it is probable that they occur here. At any rate, these or closely allied species are certain to be present in Connecticut fields and serve as important checks in any aphid infestation.

In Ohio, chickens, the English sparrow, the chipping sparrow and the quail were observed to feed on potato aphids. A fungus, *Empusa* (*Entomopthora*) sp., killed many of the aphids, particularly during rainy periods. Possibly this is the same species that

attacked the turnip aphid in Connecticut in 1916, and which was identified as *Entomopthora aphidis* Hoff. by Dr. A. T. Speare of the Bureau of Entomology.

Control Methods.

Spraying with Nicotine Solution. The means advised by the Station and practiced by many growers for immediate relief was to spray the vines with nicotine solution to kill all aphids which are hit by the spray. There are several nicotine preparations on the market, such as "Black Leaf 40," made by the Kentucky Tobacco Product Company, Louisville, Ky.; "Nikoteen," made by the Nikotine Manufacturing Company, St. Louis, Ky.; and "Pratts' Nicotine," made by The B. G. Pratt Company, 50 Church St., New York, N. Y.

One of the best-known of these preparations, and perhaps the one most widely sold in Connecticut, is "Black Leaf 40." This is a heavy liquid containing 40 per cent. of nicotine in the form of sulphate. It will kill most kinds of aphids if diluted at the rate of one teaspoonful in a gallon of water, or one-half pint in a barrel of 50 gallons. If a little soap be added, it will spread and cover the foliage better. For this purpose a piece of soap an inch square to a gallon, or two pounds to a barrel, will answer. For field spraying, therefore, to kill aphids on potatoes, the following formula should be used:

"Black Leaf 40"..... 1 pint
Laundry soap..... 2 pounds
Water.....50 gallons.

The nicotine solution may be added to Bordeaux mixture, lime-sulphur or lead arsenate, but when used in combination with these materials the soap should be omitted on account of possible chemical changes, forming soluble salts of copper, lime or arsenic, liable to injure the foliage. There was some misunderstanding on the part of the growers regarding the directions contained in the press notice issued on July 16 (See page 291), which reads: "This spray containing soap cannot be applied with Bordeaux mixture but may follow or precede it by a few days." The reason for this statement has already been explained above. Some growers wish to eliminate one spraying, and may do so by adding the "Black Leaf 40" to the Bordeaux mixture, and there is no danger if the soap is omitted.

To kill aphids very thorough work is essential. Most of the aphids are on the tender shoots and on the under side of the leaves, many of which are curled. As the spray will kill only those aphids which are hit by it, it is imperative that a successful spray be directed against the under surface of the leaves and also be thrown against the plant from opposite sides. It is almost impossible to hit all of them by a single treatment. Repeated applications are therefore necessary in some cases. It is extremely important to watch the fields and to begin spraying before the leaves curl, and before the aphids become sufficiently numerous to injure the plants. It will often be found practicable to spray in spots or sections of the field to eradicate or check aphid colonies which later might spread over the whole field, thus forestalling considerable expense and much possible damage.

Clean Culture and the Destruction of Rubbish. As the aphids feed on many weeds, including shepherd's purse, lambs quarters, wild ground cherry, red root pigweed, ragweed, etc., all such weeds should be destroyed both in and around the potato field. As this aphid passes the winter in the egg stage, usually on rose, but often on the stems of weeds, potato vines, etc., all such rubbish should be destroyed, preferably by burning.

Effect of Weather. The weather plays an important part in controlling aphid outbreaks. Heavy rains will doubtless wash many aphids from the tender shoots. Wet weather also favors the growth of fungus diseases, such as *Entomophthora aphidis*. Apparently aphids are apt to be more troublesome in a cold, wet, backward season, and often disappear altogether on the approach of hot weather. The latter, of course, is more favorable to the development of the insect parasites and natural enemies.

Literature.

Ashmead, Wm. H. Canadian Entomologist, Vol. XIV, p. 92, 1882 (Original description.)

Britton, W. E. Report Conn. Agr. Expt. Sta., p. 294, 1912 (On leaves of corn and potatoes.)

Davidson, W. M. Journal of Economic Entomology, Vol. 5, p. 411, 1912. (On wild lettuce in California.)

Davis, J. J. Journal of Economic Entomology, Vol. 4, p. 330, 1911. (Injuriously abundant in Illinois.)

Essig, E. O. Aphididae of California, Univ. of California Publications, Vol. I, No. 7, p. 329, July, 1917. (Found on yarrow, tobira and American elm.)

Fletcher, James. Rept. of Expt. Farms, Canada, p. 210, 1906. (Abundant in Ottawa, spring of 1906.)

Houser, J. S., Guyton, T. L. and Lowry, P. R. Ohio Agr. Expt. Sta. Bull. 317, November, 1917. (Entire bulletin devoted to outbreak, control methods, etc., in 1917.)

Lintner, J. A. Third Report of N. Y. State Entomologist, p. 122, 1886. (Recommendations for control.)

Oestlund, O. W. Aphididae of Minn. Geol. Nat. Hist. Surv. Minn., Bull. 4, p. 86, 1887 (Listed.)

Patch, E. M. Me. Agr. Expt. Sta. Bull. 134, p. 215, 1906. (For three seasons abundant in the vicinity of Houlton.)

Me. Agr. Expt. Sta. Bull. 147, 1907. (Entire bulletin devoted to life history, economic significance, etc.)

Me. Agr. Expt. Sta. Bull. 190, 1911. (Comparison of *M. destructor* and *M. solanifolii*.)

Me. Agr. Expt. Sta. Bull. 202, p. 178, 1912. (Occurring in large potato fields in Maine and parts of Canada.)

Me. Agr. Expt. Sta. Bull. 233, 1914. (Most common species on Japanese rose bushes.)

Me. Agr. Expt. Sta. Bull. 242, 1915. (Full general account.)

Sanborn, Charles E. Kansas Aphididae, p. 268, Vol. III. No. 1, 1904.

Webster, R. L. Journal Economic Entomology, Vol. 5, p. 471, 1912. (Abundant on potatoes at Ames, Iowa.)

Iowa Agr. Expt. Sta. Bull. 155, p. 400, May, 1915. (General appearance, control methods, etc.)

Williams, T. A. North American Aphididae, Sp. Bull. No. 1, Univ. of Nebraska, Dept. of Entomology, p. 20, 1891. (Host plant listed.)

A COCKROACH PEST OF GREENHOUSES.

Pycnoscelus (*Leucophæa*) *surinamensis* Linn.

By M. P. Zappe.

This introduced cockroach was first discovered in Connecticut in the greenhouses of A. N. Pierson, Inc., at Cromwell, on March 1, 1911, by Mr. B. H. Walden, assistant entomologist of this Station. At that time the roaches were present under boards and in cracks but were not very abundant. Mr. Pierson informed him that the insects had been present for several years but that they had done no damage. Little attention was paid to them, therefore, until the spring of 1917, when they had become so numerous that they caused considerable damage in some of the houses by gnawing the bark from the stems of the plants as shown on plate XII, b. After trying to poison the roaches with bait containing arsenic, without much success, Mr. Pierson sent specimens to this Station

and asked for advice in controlling the pest. The specimens arrived on April 30, 1917, and, though immature, they were identified by Mr. Walden as *P. surinamensis* Linn. Mr. Pierson wrote in part as follows:

"They are found chiefly in the rose benches, hiding during the day in the soil. At night they come up, apparently in great numbers, and gnaw the bark of the rose plants about two inches from the surface of the ground, making a clean job of it."

A visit was made to the greenhouses on May 7th, and these insects were found to be very abundant. They fairly swarmed in the loose soil in the corners of the rose benches, and under loose boards, boxes, pails, etc. They had already done considerable damage to newly-set rose plants and to Easter lilies by gnawing the stems. As still greater damage seemed imminent, if the pest was not soon checked, we undertook to carry on a few experiments with stomach and other poisons in order to determine a satisfactory method of control.

As little has been published in this country about this particular species of cockroach and its status as a possible pest, all available information has been incorporated with the notes of our experiments in this bulletin.

Damage and Habits.

The damage done during the spring of 1917 amounted to several hundred dollars in this one house. The owner had just set young rose plants on benches which had been idle for about four weeks. These were immediately attacked by the young roaches (there were very few adults present at this time) and nearly all of them were girdled at the base, as shown in plate XII, b. When the roaches are full grown they climb up the plants and eat the leaves rather than the bark on the stems. Much damage was also done to Easter lilies. Here the young sprouts from the bulbs, as well as large plants, were attacked. On the larger plants the bark was chewed off the main stem, as shown on plate XIII. In another house they were eating the bark of the stems of poinsettias.

These roaches spend the day in the soil in the benches, in cracks in the boards on the sides of benches, under boards, barrels, in cracks and holes in the walls of the building, etc., wherever it is

dark and there is a chance to hide. A trowelful of soil from the corner of a bench would sometimes contain from 30 to 40 young cockroaches. A small board or shingle left on a bench undisturbed for a few days would shelter large numbers of them. During the day the roaches are rarely seen and when some are uncovered they run for the nearest shelter, or crawl down into the soil if possible. At night they come out to feed and the walks and benches are covered with them. When feeding they do not seem to mind the light from a lantern. In the house where the roaches were most numerous, the benches were low, being right on the ground and known as solid benches; the sides were boarded up, and the boards were full of knot holes and cracks, making ideal places for roaches to hide. Most of the roaches were near the sides of the benches where the soil was not too wet, and where it was not packed down as hard as in the middle; they were very seldom found hiding in the center of the benches.

Distribution.

The present species is circumtropical in distribution, extending its range frequently into subtropical regions. It is abundant in the peninsula of Florida and the Brownsville region of Texas. It has been found established as far north as Jacksonville, Gainesville and Cedar Keys, Florida; New Orleans, Louisiana, and San Antonio, Texas. Elsewhere in the United States the species has become temporarily established in greenhouses and places similarly heated during cold weather. It has been taken in the reptile house of the New York Zoological Society in New York City; also at Rutherford, N. J., Washington, D. C., and Cromwell, Conn. An immature specimen taken from a bunch of bananas has been recorded from Toronto, Ontario.

Professor A. P. Morse of Wellesley College reported it doing damage in a conservatory at Wellesley, Mass., in company with the Australian cockroach, *Periplaneta australasiae* Fabr.

Outside of the United States *Pycnoscelus surinamensis* has been taken in* Cuba,[7] Bahama,[6] Porto Rico,[7] Dominica,[2] Trinidad,[1] Barbados,[11] Martinique,[11] Grenada,[11] St. Vincent[11] and Jamaica[11] Islands of the West Indies, Bermuda,[9] Mexico,[11] Costa Rica,[11] Brazil[11] and Guiana[11] on the American continent, Sumatra,[8] Lom-

* Numbers refer to literature at end of this paper.

bok[4] and Java[11] of the East Indies, Philippine Islands,[11] Lower Siam,[8] Singapore, Straits Settlements,[3] Amoy, Southern China,[11] and Senegal, northwestern Africa.[11]

Probable Manner of Introduction.

This cockroach was probably first brought into Connecticut with shipments of plants or fruit from South or Central America, Florida or Texas. Florists have for many years imported palms, ferns, orchids, and various other tropical plants, and thousands of shipments of pineapples and bananas come each year into the northern states.

No official inspection was made of any imported plants entering the State until 1909 when nests of the brown-tail moth were found on fruit stock grown in France. For three years the larger shipments of stock imported by nurserymen were inspected, but doubtless many small shipments were brought in by private owners, and extensive importations made by florists. These were not inspected because there was no way to trace them. In 1912 the Federal Horticultural Board was established, and its system of permits and notices has made it possible to trace all shipments entering the state since that time. All woody, field-grown plants have been inspected but it has not seemed necessary to attempt the inspection of all herbaceous or tender greenhouse plants, and no inspection of fruits has been attempted.

This cockroach must have entered Connecticut at least as early as 1909, and perhaps earlier, and the chances are good that it came in with plants. Nymphs of this species were intercepted at Cromwell, Conn., in the spring of 1915, on a shipment of Araucarias from Belgium, and it has been found in the District of Columbia with plants imported from Straits Settlements. This and other species of cockroaches have been found frequently by horticultural inspectors in the District of Columbia, New York, New Jersey and Connecticut. In many cases the roaches were immature, and the infestation reported under the name of "cockroach," and the species not identified. Most of the roach infestations have been in shipments of orchids, palms, and araucarias. The greatest number of intercepted specimens have come from Colombia 29, Brazil 8, Venezuela 6, Belgium 1, Guatemala 1, Straits Settlements 1, Azores 1, Antiqua, British West Indies 1, and Philippine Islands 1.

Synonymy.

1758, *Blatta surinamensis* Linn. 1838, *Panchlora surinamensis* Guer. 1862, *Pycnoscelus obscurus* Scudd. 1865, *Leucophaea surinamensis* Brunn.

Other established synonyms of the present species are:

Blatta indica Fabr. *Blatta melanocephala* Stoll. *Blatta punctata* Eschscholtz. *Blatta corticum* Serville. *Panchlora celebesa* Walker. *Panchlora submarginata* Walker. *Panchlora occipitalis* Walker.

Description.

Female*

Form robust, structure rather heavy. Head flattened, eyes well developed. Maxillary palpi short and stout. Pronotum with glabrous surface showing minute, rather widely separated pits. Wings transparent except in narrow area of the irregular costal veins and distal portion of anterior field where they are translucent. Styles very short, joints much fused, acuminate tip flattened, dorsal surface weakly convex, ventral surface more strongly convex proximad. This species is easily separated from the other common roaches of North America by having the ventral margins of the femora unarmed, or supplied with few distal spines. Head shining, blackish brown; legs brown; tegmina translucent, blackish chestnut brown. Abdomen with dorsal surface dark brown, ventral surface polished, broadly margined with blackish brown, shading into brilliant, suffused cinnamon rufous in large mesal portion. Pronotum shining, blackish brown, with marginal traces of buffy latero-cephalad. General coloration of immature specimens deep chestnut brown to blackish chestnut brown. Head, pronotum, mesonotum, metanotum, median segment, first two dorsal abdominal segments and ventral surface polished, with very minute, scattered microscopic punctae on head and dorsal polished portions. Remaining dorsal portions of abdomen microscopically finely shagreened, showing raised and polished points on third segment and fewer raised points on the remaining segments. Head of general color shading to slightly paler on the occiput. The female is shown on plate XIV, a.

Eggs.

Eggs are often laid in the soil by the females. When first laid they are whitish yellow, later becoming darker. Egg masses are

* From Blattidae of North America, by Morgan Hebard.

slightly curved as shown on plate XII, c, and vary in size, the larger ones being about 10 mm. long and 3 mm. wide. The embryos in the egg mass are well developed before the eggs are laid and when an egg mass is broken open the young roaches appear to be ready to hatch. The eyes, mandibles and spines on the tibiae are brown and the rest of the body is white. The eggs in each mass vary from 14 to 42 in number, the average being 24.

Egg Laying Habits.

When roaches have been injured, or very much excited, they will often lay an egg mass which as a rule is not very well developed and in the laboratory has never produced young.

A number of adult roaches in a cage were kept at a temperature of about 36° F. for a few days. After a short time they were all on their backs, apparently dead, but when they were removed to a warmer room many of them came back to life and laid quite a number of egg masses. In our experience none of these egg masses or those found in the soil or in the cages have ever hatched. Sometimes a female will eat her own e gs.

Very little is known of the reproduction of this species but from our observations it would seem that normally the young roaches are either born alive or hatch from eggs within 24 hours.

Is the Species Parthenogenetic?

Though the male has been described and occurs in the East Indies, Mr. Hebard* states that he has examined several hundred specimens from the United States, Mexico and the West Indies without finding a single male, adult or immature, from the American continent. Over 1,000 specimens from Mr. Pierson's greenhouses were examined, and all were females. These facts point toward parthenogenesis, but do not prove it.

Control Experiments.

A number of poisons were used in various combinations to control this cockroach, but only a few were found that were of any value at all. Some of them would kill the roaches but not in large enough numbers to pay for the treatment. The object of these experiments was to find a quick and also a cheap way to get rid of this pest. Following is a list of those poisonous baits which

* Ibid. page 196.

under ordinary conditions would hold this insect in check and would be useful in small infestations of this cockroach.

Effective Poison Baits.

PHOSPHORUS PASTE.

This paste is made of flour, glucose, honey, and from 2% to 4% of phosphorus. This comes in two-ounce tubes and may be purchased in nearly all drug stores. The price is 25 cents for a two-ounce tube and would be a very expensive treatment for a large greenhouse. The roaches are very fond of this bait and are easily killed by it. A home-made phosphorus paste was made at the Experiment Station chemical laboratory which worked as well as the commercial paste but it is not recommended for general use. Yellow phosphorus, from which this paste is made, is highly inflammable and must be kept under water. It is, therefore, very dangerous for anyone not acquainted with its properties to handle it. There is also danger from fires if too high a percentage of phosphorus is used in the paste.

BORAX.

This is the next best remedy for this cockroach and has some advantages over the phosphorus paste. It is cheaper, non-poisonous to man, easily handled, and can be used in several combinations. It is slower in its action on the roaches than phosphorus. After eating borax the roaches first lose the use of their legs and may be seen slowly crawling around on top of the soil in the benches or on the walks, and later they die.

A mixture of borax, powdered sugar and cooking chocolate, equal parts of each, ground up together in a mortar and made into a paste with honey and water, was tried and killed many roaches. This was eaten slowly and was not all cleaned up for a week. Dead roaches were found every day and for a few days after the bait was all eaten.

Another formula tried was:

Borax.....4 oz.
Flour.....4 oz.
Bananas.....3.

Three over-ripe bananas, flour and borax were made into a paste and applied to several benches. This was all eaten in a few days and dead roaches found.

A bait made of powdered sugar and borax in equal parts was used with good results. It has the advantage of being easier to mix and apply and is also cheaper than any of the other borax combinations tried. The results were about the same. To a part of this mixture a few drops of anise oil were added to make it more attractive. This was eaten a little sooner than the portion without anise oil. Such was the case whenever anise oil was added to any bait that roaches would eat.

Some of the following poisons were eaten by roaches, and others were not. Those that were eaten were of very little value in holding the insect in check.

STRYCHNINE.

Strychnine.....2 grams.
Wheat bran.....1 pint.
Glucose and water enough to moisten.

The strychnine was dissolved in a little water, the glucose added, and the mixture then used to moisten a pint of bran. Roaches ate this fairly well but very few dead ones were found. This formula was also tried with the addition of a few drops of anise oil with no better results.

Strychnine.....2 grams.
Flour.....1–2 lb.
Sugar enough to sweeten.

This was all eaten and a few dead roaches found.

ARSENICAL POISONS

This species of cockroach seems to be very resistant to the effect of arsenicals. Only a few of the following were eaten at all, and where they were, no dead roaches were found.

Arsenate of lime.....10 grams
Flour.....1–2 lb.
Sugar to sweeten.

All of this was eaten but no dead roaches were found.

Arsenate of lead.....5 grams (dry powdered).
1 over-ripe banana.

This mixture was eaten but no dead roaches were found.

Arsenate of lead, 5 grams, was worked into one-fourth pound of lard. Little red ants began to eat this as soon as it was put down.

The heat in the greenhouse was enough to soften the lard so that it ran all over the paper upon which it was placed. I do not know whether the roaches ate any of this or not, but no dead roaches were seen.

Paris green.....4 oz.
1 Orange
1 Lemon
Molasses.....1 pint.
Middlings.....5 lbs.
Water.....3 qts.

This formula is recommended for cutworms, but proved to be of no value against this cockroach, as none of the mixture was eaten.

White arsenic.....2 oz.
Flour.....1 lb.
Sugar.....2 oz.

These ingredients made into a thin paste with water were left untouched.

On two benches the stems of the rose plants were painted with a thick solution of lead arsenate. These plants were not injured.

Rose branches—parts of plant cut off when pruning—were dipped in a solution of lead arsenate. Leaves and all were partly eaten every night. After the first night the leaves would be wilted and the roaches would not eat any more of this material.

Arsenate of soda.....150 grains
Sugar..... 2 oz.
Beer..... 6 fluid oz.
Water enough to make a pint.

This was used to moisten bran and was placed on benches. I could not tell if this was eaten very much as men watering the plants may have washed most of it into the soil. At this time the men working in this greenhouse used some commercial phosphorus paste at night and many dead roaches were found. Some of these were collected and their stomach contents analyzed by Mr. C. B. Morison of the Chemical Department. He found no trace of arsenic but large quantities of phosphorus. This shows that the arsenic was not responsible for their deaths.

CYANIDE OF POTASSIUM.

Cyanide of Potassium.....1–4 oz.
Flour.....1 lb.
Sugar to sweeten.

Cyanide was dissolved in a little water and mixed with the flour and sugar to make a thin paste. When this was mixed it smelled very strong of cyanide but the next morning it was all eaten. Even the paper upon which it was placed was devoured, big holes being eaten out where the poison touched it, as shown on plate XIV, b. Cyanide, although a very deadly poison, had no apparent effect on these cockroaches and no dead ones were found.

Flour.....1 lb.
Cyanide of Potassium.....10 grams.
Arsenate of lead.....10 grams.
Sugar..... 2 oz.
Water to make a thin paste.

In this case cyanide and arsenate of lead were used together and the mixture was all eaten by the roaches, but no dead ones were found.

Flour.....1–2 lb.
Cyanide.....1–4 oz.
Phosphorus (Red).....1–2 oz.
Glucose.....2 tablespoonfuls
Water to make a thin paste.

This, like the preceding, was all eaten, but did not kill the roaches.

RED AMORPHOUS PHOSPHORUS.

Flour.....1–2 lb.
Red Phosphorus.....1–2 oz.
Glucose.....2 tablespoonfuls
Water to make a thin paste.

The phosphorus used in this formula is poisonous but is not dangerous to handle like the yellow phosphorus. It has the characteristic phosphorus smell and was thought to be a good substitute for the phosphorus paste. The cockroaches ate this bait but it did not kill them.

Lard.....1–4 lb.
Phosphorus (Red).....5 grams.

This was mixed and spread on pieces of paper but the heat in the greenhouse made the lard soft and it began to run. Ants immediately began to feed on this mixture. I do not know whether roaches ate any of this or not but no dead ones were found.

MERCURIC CHLORIDE.

Mercuric Chloride.....10 grams
Flour.....1–2 lb.
Glucose.....1 tablespoonful.
Water to make a soft paste.

This formula was tried, one-half with a few drops of anise oil, and the other without, but the roaches would not eat it.

PLASTER OF PARIS.

Plaster of Paris.....1–2 lb.
Flour.....1 1–2 lb.
Powdered sugar.....1–4 lb.

These ingredients were mixed dry and were placed in shallow flower pots where the roaches could get at it. Dishes of water were placed near the bait, the idea being that the roaches would eat the bait and drink the water, and the plaster of Paris would set in their stomachs, thus killing them. The roaches did not eat any of this mixture but sowbugs did, although no dead ones were found.

REPELLENTS.

Sawdust was moistened with fish oil and sprinkled around the plants where the roaches had been doing the most damage. This kept them away from these plants for a few nights, but when the plants were watered the sawdust was washed away and the mixture lost its usefulness. Sawdust and kerosene was also tried with about the same results as the above except that any roaches that came in contact with the kerosene were killed.

TRAPS.

Large glass jars baited with stale beer were sunk into the benches almost to the level of the soil. These worked fairly well but cannot be considered as effective traps, as the roaches were

not caught in large enough numbers. For small infestations they would perhaps be satisfactory but in this case it was too slow a method of control.

KEROSENE SPRAY.

Our experience with kerosene as a repellent led us to try it as a contact spray. Pure kerosene sprayed along the top and sides of the benches brought out all the cockroaches which were near the sides and surface of the benches. As this is the place where most of the roaches stay during the day, great numbers of them were killed in this way. On one side of one bench, in spraying only four feet in length of the bench, 184 roaches were killed. In one corner of the house where the masonry was broken there were many holes in which the roaches hid during the day. Kerosene was sprayed into these holes and the roaches came tumbling out. When they came in contact with the oil they were all killed and the ground was literally covered with dead roaches.

Kerosene will burn the foliage, so great care must be taken not to get any spray on the leaves of the plants. The owner of the greenhouse used the treatment and so reduced the numbers of the roaches that there was no longer any danger of their doing serious damage to his plants.

LITERATURE.

1. Bruner, Lawrence. Report on the Orthoptera of Trinidad, West Indies. Jour. N. Y. Ent. Soc. XIV, p. 141, 1906.
2. Caudell, A. N. Orthoptera of Yale-Dominican Expedition of 1913. Proceedings U. S. National Museum, Vol. 47, p. 491, 1914.
3. Ehrhorn, E. M. Hawaiian Forester and Agriculturist, Honolulu, XIII, No. 2, p. 44, Feb., 1916.
4. Hebard, Morgan. Blattidae of North America, pp. 193 and 269, 1917.
5. Insect Life. Vol. V, p. 201, 1893.
6. Morse, A. P. Some Bahama Orthoptera. Psyche XII, p. 19, 1905.
7. Rehn, J. A. G. Studies in American Orthoptera. Trans. Am. Ent. Soc., XXIX, p. 284, 1903.
8. Studies in Old World Forficulids or Earwigs and Blattids or Cockroaches. Proceedings U. S. National Museum, Vol. XXVII, p. 558, 1904.
9. Scudder, S. H. Psyche VIII, p. 43, 1897.
10. List of Orthoptera of New England. Psyche IX, p. 100, 1900.
11. North American Orthoptera, pp. 47, 157, 239 and 280, 1901.
12. Smith, J. B. Insects of New Jersey, p. 151, 1900.
13. Walden, B. H. Orthoptera of Connecticut. State Geological and Natural History Survey, Bull. No. 16, p. 53, 1911.

ERADICATING THE LITTLE HOUSE ANT OR PHARAOH'S ANT FROM A DWELLING HOUSE.

By M. P. Zappe.

A serious outbreak of the little house ant or "Pharaoh's ant" was reported by a family in Hartford late in November 1916. This ant had been present in this house for several years but had not caused much annoyance until the summer of 1916. In other years it had confined its activities to the pantry and kitchen, and at the beginning of cold weather would disappear until the following summer. But this year the ants were running all over the house, no part of it being free from them. At this time there were many queens around the house, as well as worker ants. A favorite place was the bathrooms, where they could be seen drinking water and running along the tile floor. There were ants in every room in the house; a few could be found on tables, writing desks, among clean clothing in bureaus, on the floors, walls, etc. The lady of the house had been fighting them all summer and was on the verge of a nervous breakdown. She was willing to do almost anything to get rid of this pest, even threatening to tear the house down.

Naphthalene flakes had been used but its effect was only local, merely driving them out of the room where it was used. The family objected to the smell of naphthalene so it could not be used all over the house. Trapping with a sponge dipped in a sweetened solution, and when full of ants, dropping it into hot water, killed many ants but they soon became suspicious of the sponges, after which very few would venture to go into them.

On December 1, 1916, a poisoned bait recommended by the Bureau of Entomology, Washington, D. C. (Farmers' Bulletin 740) was tried. The formula for its preparation is as follows:

1 lb.	sugar
125 grains	arsenate of soda
1 qt.	water
1 tablespoonful	honey.

Dissolve sugar in the water and add the arsenate of soda. Boil until sugar and poison are all dissolved, then add the honey. The addition of the honey is said to make the bait more attractive to the ants. When cool this mixture was used with bits of sponge on small, shallow dishes and two or three dishes placed in each room. The object of this poisoned bait is not only to kill the ants

which collect and carry the sirup back to the nests, but also the young and the queens in the nest which feed on it. In less than two hours after distributing the poison around the house, the ants began to find the bait and large numbers were feeding on it and carrying it back to the nest. Even the queens were seen at this bait. A few days later another batch of bait was made up, but this time either it was boiled too long or too much honey was added. When it cooled it was too thick for the ants to eat readily. On December 6 the same formula was tried again except that only one-half pound of sugar was used. This made a thinner sirup which did not dry and harden as quickly as the sirup made from one pound of sugar. The ants seemed to eat this better than the thicker sirup. At this time there seemed to be fewer ants in the front of the house but just as many in the kitchen, where no poisoned bait was used.

The house was visited again on December 15 and very few ants were found on the first floor. A few were found in the bathrooms of the second floor where they were drinking water from the toilets and washbowls. Oxalic acid has been recommended as a remedy for ants by some writers. This was tried in combination with lard but the lard and acid did not mix, so lard was melted and the acid added. This stayed mixed until cool; then it separated. Ants did not eat any of the mixture.

On December 18 no ants could be found on the first and second floors. Two bathrooms on the third floor had a few living ants and many dead and dying ones were curled up on the floor. A poisoned bait of beef liver (2 oz.) and potassium cyanide (150 grains) was made up by chopping the liver fine and adding the cyanide in a water solution. There were so few ants left that we could not tell whether they ate any of this or not. Early the following spring (March 23) the house was visited again but no ants had been seen in the house since December 18, when the last poisoned bait was used. A recent letter states that the ants have never returned, much to the joy of the family.

A NEW FRUIT PEST IN CONNECTICUT.

Laspeyresia molesta Busck.

On July 11 specimens of peach shoots were received from Mr. C. C. Lawrence of the F. A. Bartlett Company, Stamford, who wrote as follows:

"Am sending you under separate cover some specimens of peach twigs, the terminal shoots of which have been attacked by a small insect. Very possibly this may be due to the peach twig borer but the color of the larva is such as to suggest that it might be *Laspeyresia molesta*, brought over from Japan and reported by Dr. Quaintance. In talking with Dr. Quaintance this spring, he mentioned the fact that it had not been found outside the District of Columbia, Maryland and Virginia. Do you suppose it is this insect?"

The specimens were examined and the letter answered by Mr. Lowry as follows:

"Your letter of July 10th, also the package containing the peach twigs, have been received in the absence of Dr. Britton. The twigs were quite badly crushed and it was possible to obtain only one larva. If you would be so kind as to send us more material in a box, it would be greatly appreciated. As you suggest, the damage is probably caused by the larva of *Laspeyresia molesta*."

Specimens were sent to the Bureau of Entomology by Mr. Lawrence or his firm and the insect was identified positively as *Laspeyresia molesta*. Mr. E. H. Siegler of the Bureau, in company with Mr. F. A. Bartlett, visited several orchards in the vicinity. They found the insect not only in Stamford but also in Norwalk near the border of New Canaan, in the twigs of a bearing peach orchard. Though a nearby nursery was examined, no trace of the insect could be found on nursery stock. The assistants engaged in inspecting nurseries were instructed to be on the watch for this pest, but they did not find it anywhere during the progress of their work.

As this insect is new to Connecticut, and was described in 1916 as being new to science, a brief account of it is given here, taken chiefly from Quaintance and Wood.* The following description from their paper is reproduced here:

Full Grown Larva. "Thirteen to fifteen mm. long; whitish suffused with pink; tubercles minute, black. Head light brown with darker brown markings; hind margin, ocellar area, and the tips of the stemmata black. Thoracic shield light yellow, edged with brown. Spiracles small, circular, dark brown. Anal plate blackish fuscous. Legs and prolegs normal."

* Journal of Agricultural Research, Vol. VII, page 373, November 1916.

The adult has a wing-spread of about half an inch, and belongs to the family Tortricidae. The following is the original description by Mr. Busck:

Adult. "Head dark, smoky fuscous; face a shade darker, nearly black; labial palpi a shade lighter fuscous; antennae simple, rather stout, half as long as the forewings, dark fuscous with thin, indistinct, whitish annulations. Thorax blackish fuscous; patagia faintly irrorated with white, each scale being slightly white-tipped. Forewings normal in form; termen with slight sinuation below apex; dark fuscous, obscurely irrorated by white-tipped scales; costal edge blackish, strigulated with obscure, geminate, white dashes, four very faint pairs on basal half and three more distinct on outer half besides two single white dashes before apex; from the black costal intervals run very obscure, wavy, dark lines across the wing, all with a strong outwardly directed wave on the middle of the wing; on the middle of the dorsal edge the spaces between three of these lines are more strongly irrorated with white than is the rest of the wing, so as to constitute two faint and poorly defined, white dorsal streaks. All these markings are only discernible in perfect specimens and under a lens; ocellus strongly irrorated with white, edged by two broad, perpendicular, faint bluish metallic lines and containing several small, deep black, irregular dashes, of which the fourth from tornus is the longest and placed farther outward, so as to break the outer metallic edge of ocellus; the line of black dashes as well as the adjoining bluish metallic lines are continued faintly above the ocellus in a curve to the last geminate costal spots; there is an indistinct, black apical spot and two or three small black dots below it; a thin but distinct, deep black, terminal line before the cilia; cilia dark bronzy fuscous. Hind wings dark brown with costal edge broadly white; cilia whitish; underside of wings lighter fuscous with strong iridescent sheen; abdomen dark fuscous with silvery white underside; legs dark fuscous with inner sides silvery; tarsi blackish with narrow, yellowish white annulations."

Injury.

The larvae have been found injuring the twigs not only of the peach, but of the plum and cherry, and also the fruit of the peach. In one orchard between 80 and 90 per cent. of the twigs had been injured, and adjacent nursery stock showed even a higher percentage of injury. This injury begins soon after new growth starts in spring and continues until growth ceases in the fall. The larvae seem to prefer the tender growing shoots, and may pass from one into another. Thus one larva may tunnel and injure several shoots. The injury to twigs closely resembles and is scarcely distinguishable from that caused by the common

peach-twig borer or peach moth, *Anarsia lineatella* Zell. Apparently the peach is preferred to the plum and cherry. This twig injury checks growth and on the peach is followed by an exudation of gum; it is more serious in a nursery than on bearing trees.

Though considerable injury results from the attack to the twigs, it is the attack on the fruit of the peach which causes the greatest damage. The larvae eat through the skin near the stem, beginning their attack on the green fruit, but as the fruit approaches maturity it becomes more seriously infested. Ripening peaches often have several larvae in a single fruit, and following the mutilation, brown rot finishes the destruction. The larvae will also enter the fruit at other places, especially if damaged by hail or punctured by curculio. Many of the infested peaches fall to the ground, but some will hang upon the tree. Since this article was written it has been discovered that the larvae infest not only peach but also the fruit of apple, pear and quince.

Life History.

The winter is passed by the full-grown larva on the tree, probably making winter cocoons in the cracks of the bark or in cavities eaten into the bark on the twigs. Early in the spring the larva enters the pupa stage. In summer, cocoons are sometimes made in the cavity at the stem end of the fruit. The cocoon is made of whitish silk. There are probably two or three broods of larvae each year. The adults emerge and begin to lay eggs soon after growth starts on the tree, as larvae have been observed at work on the twigs when the new shoots were from six to eight inches long. Thus the larvae begin early in the season and they are found in different stages at work on the twigs until late in the fall.

Possible Control Measures.

It is too early to recommend control measures, as experiments have not yet been conducted to determine the best methods of treatment. Only a few possible measures can be pointed out here. The cocoons and larval cases are so close and impervious that fumigation with hydrocyanic acid gas does not seem to be a satisfactory remedy. Possibly dipping the trees in a miscible oil may prove more effective. This can easily be carried out when the trees are dug for shipment.

In the bearing orchard early spraying with lead arsenate soon after the fruit sets will probably reduce the injury to the fruit, as in the case of the codling moth which attacks the apple.

The larvae tunnelling in the twigs are mostly out of the reach of arsenical poisons. Clipping off the twigs in winter—a customary practice in heading back orchard trees—will undoubtedly remove a small percentage of the larvae. These twigs should be gathered and burned before the trees start into growth.

THE FALL WEB-WORM.

Hyphantria cunea Drury.

Nearly every year in the latter part of the summer nests of the fall web-worm are present on orchard, shade and woodland trees throughout the State. These are more prevalent in some seasons than others, and it is, of course, when most abundant that the insect is the most destructive. In 1901, the fall web-worm was exceedingly prevalent. It continued to be abundant through 1902 and 1903, though diminishing somewhat. From then until the present, the nests have not been rare, though not sufficiently common to receive particular mention in the annual report of this Station. In 1916 this insect was noticeably more common than for several years preceding, and in 1917 it was probably more prevalent than since 1902. As no adequate account of this insect has ever been published in this series of reports the present paper was prepared to supply the want.

Relationship to Other Insects.

The fall web-worm is the larva of a moth belonging to the family Arctiidae or tiger moths. Most writers consider it to be *Hyphantria cunea* Drury, but some recognize it as *H. textor* Harr., while others consider the two species as identical, *textor* being a synonym, or possibly a variety of *cunea*. The Station collection contains one adult specimen labeled *textor*, and all others are labeled *cunea*. The writer has made no attempt to separate the two species. For the purposes of this article it really makes no difference. In Smith's List of Lepidoptera, 1st edition, published in 1891, *textor*, *punctatissima* and several other names are given as synonyms of *cunea*. In the 2nd edition, published in 1903,

and also in Dyar's List of Lepidoptera, published in 1902, *cunea* and *textor* are given as separate species. In the recent Check List of Lepidoptera by Barnes & McDunnough, they are also given as distinct species.

Dr. E. P. Felt* states that "the web made by the larva of the more common species in this state (New York) belongs to *Hypantria textor* Harris" and that *cunea* may also occur "but appears to be rarer than the other species." In Banks' Index of American Economic Entomology, the references are given under *cunea*. As most of the references in literature have been given under the name of *cunea*, this name is used in the present paper.

Injury and Habits.

The caterpillars injure trees of nearly all kinds by feeding upon the leaves, often defoliating them. The nests or webs usually occur on the ends of the branches. In this respect the fall web-worm differs from the tent-caterpillar (with which it is sometimes confused), which makes its nests in the forks of the main trunk or branches. The latter insect makes its nests in May and those of the fall web-worm appear in July, August and September. Moreover the tent-caterpillars go out of their nests to feed, and the fall web-worms always feed inside their nests, as shown on plate XVII, b. When the leaves have been eaten, they extend their nests to include fresh leaves and proceed to devour them. In this way the nest may become so large as to involve the whole branch. All caterpillars hatching from a single egg-cluster probably live and feed together in one nest.

When fully grown the caterpillars leave their nest and crawl about seeking a place to transform. They are then from one to one and one-half inches in length and are covered with brownish hairs. The hickory tree shown on plate XVIII was entirely defoliated by fall web-worms in New Canaan in 1901.

Food Plants.

Some years ago the Bureau of Entomology of the U. S. Department of Agriculture at Washington, D. C., compiled a list of food plants containing 120 different kinds of trees, shrubs and plants, upon which the caterpillars feed. This includes nearly

* Insects Affecting Park and Woodland Trees, i. page 143, 1905.

all the fruit, shade, ornamental, and native woodland trees. Pear, apple and cherry are commonly attacked. Elm, willow, poplar, hickory, black walnut, black cherry, choke cherry, ash, box elder and hackberry are common food plants, often being wholly or partially defoliated. We may therefore expect to see this insect on almost any kind of tree or shrub grown in the State.

Number of Broods.

There is usually but one brood each season in Connecticut, the caterpillars appearing in late summer. In 1904, the writer observed one of the nests in New Haven, June 23, and rearing adults, found that they laid eggs and that a second brood of caterpillars had hatched by August 15. These caterpillars were fed until nearly full grown, but as all members of the staff were obliged to be away inspecting nurseries, they were not fed and all died from starvation before transforming. This indicates that the fall web-worm is partially double-brooded in Connecticut. Since 1904, an occasional nest has been noticed in early summer, but most of them are seen later in the season.

Beutenmüller* states that this insect is double-brooded in the vicinity of New York City, and Smith† records two broods as being normal in New Jersey. According to Dr. Howard,‡ there are two broods in Washington, D. C. On the other hand, Fernald has studied the life history of this insect carefully in Massachusetts and finds only one annual brood in that latitude.

Life History.

The adult female lays on the under side of a leaf a cluster containing between 400 and 500 eggs. This cluster is shown on plate XVI, b. The eggs hatch in about ten days and the caterpillars feed gregariously and form a nest on the end of the branch. In about six weeks they become full-grown and pupate under rubbish, or attached to fences, tree trunks, etc., in light-brown cocoons covered with the hairs from the caterpillars. The principal or late brood passes the winter in these cocoons. Where

* Bulletin, American Museum of Natural History, Vol. X, page 376, 1898.

† Insects of New Jersey, page 439, 1909.

‡ Farmers' Bulletin No. 99, U. S. Department of Agriculture, page 20, 1899.

there are two broods the adults emerge in May, but in the north where the insect is normally single-brooded the adults do not appear until July. Where double-brooded, the first-brood caterpillars transform to pupae about July 1st and the adults emerge about a month later.

Description.

Egg. 0.55 mm. in diameter, globular. Surface finely sculptured or pitted. Light green or yellow when first laid, changing to a lead color before hatching. Laid usually on the under side of a leaf in a cluster containing from 400 to 500 eggs, covered with whitish hairs from the body of the female.

Larva. When first hatched, pale yellow with two rows of dark tubercles along the back, these tubercles bearing hairs. When fully grown from 30 to 35 mm. in length; color variable. Mostly striped with dark brown or black and yellow. Some individuals are nearly solid brown, some nearly black, while others are gray or lead color. There are two rows of black and orange dorsal tubercles bearing hairs which are mostly light brown but some are nearly black and others white. These tubercles are really part of a series of transverse rows, one row being borne on each segment, and, except ventrally, surrounding it. The tubercles all bear hairs nearly uniform in length, giving the caterpillar a distinctly hairy appearance. Head and legs vary from light brown to black.

Pupa. 8-10 mm. long, brown, with a more or less distinct swelling near the middle and with the spiracles showing as projections along the sides. Enclosed in a thin, light gray cocoon, in which larval hairs and particles of dirt are mixed. The cocoons are usually formed in clusters in the crevices on trunks of trees, underneath fences, rubbish on the ground, etc.

Adult. Wing-expanse 25-35 mm. Front and rear wings white, the front wings either pure white or more or less well-marked with black spots. In the most prominently marked specimens these spots form six curved transverse rows; this form has been described as *punctatissima*. The immaculate form has been described as variety *budea* Hübn. There are all gradations between these two forms. The rear wings often have one or more black spots but many are immaculate. Femora yellow, tibiae black. Eggs, adult and small larvae are shown on plate XVI.

Parasites and Natural Enemies.

No doubt some of the birds, like cuckoos, shrikes, etc., which commonly attack hairy caterpillars, feed upon the fall web-worm. Perhaps the most important natural enemies are the four-winged or parasitic flies belonging to the order Hymenoptera. Of these, three of the most important are *Apanteles hyphantriæ* Riley, *Meteorus hyphantriæ* Riley, and *Campoplex* (*Limneria*) *pallipes* Prov. An egg parasite, *Telenomus bifidus* Riley, is said to sometimes destroy nearly all eggs in the cluster. In addition to the parasites mentioned above, the following have been reared from this or some other species of *Hyphantria*: *Campoplex fugitivus* Say, *Apanteles lacteicolor* Viereck, *Pteromalus* (*Dibrachys*) *boucheanus* Ratz., *Syntomosphyrum esurus* Riley and *Eremotylus glabratum* Say. A dipterous parasite of the family Tachinidae, genus *Tachina*, has been recorded by Dr. C. V. Riley*, who states that this fly is fully as useful as any of the other insect parasites.

In addition to the parasites, there are several predaceous insects that devour the larvae. These include the soldier bugs, *Euschistus servus* Say and *Podisus maculiventris* Say, in the Southern States the praying mantis, *Stagmomantis carolina* Linn., and the wheel bug, *Prionidus cristatus* Linn., and the larva of a Carabid beetle, *Plochionis timidus* Hald. The adult moths are eaten by various species of birds, spiders, dragonflies, robber flies, and the large ground beetle, *Calosoma scrutator* Fabr.

In Kentucky in certain years the caterpillars are killed by a fungus, *Empusa gryllii* Fres.

Control Methods.

There are two common methods of controlling this insect on orchard and shade trees, but in the woodlands there has been no attempt to combat it. On small trees that can easily be reached, it is a simple matter to clip off and burn the nest when first formed and small, before the tree has been injured. Tree pruners can be used for this purpose on larger trees. It is also feasible to kill the caterpillars in their nests on the tree by means of a torch. This will not seriously injure the tree as might be

* Bulletin No. 10, Division of Entomology, U. S. Department of Agriculture, page 52, 1887.

the case with the tent-caterpillar, where the nests are in forks of the branches. Fall web-worm nests are at the ends. The use of the torch will scorch some of the nearby leaves as well.

Spraying with lead arsenate, using at least three pounds of the paste (or one and one-half pounds of the powdered or dry form) in a barrel containing fifty gallons of water, will prevent any serious or marked defoliation of the tree. This is, of course, the method generally practiced in Connecticut orchards, which need to be sprayed systematically in order to obtain good fruit. Shade trees can also be sprayed, and are sprayed in many Connecticut towns and cities. The expense of spraying woodland would be prohibitory. Certain small areas are sprayed each year in gipsy-moth infested regions in the eastern part of the state, and of course the spraying effectually controls the fall web-worm.

Literature.

Berger, E. W., Observations upon the Migrating, Feeding, and Nesting Habits of the Fall Web-worm, *Hyphantria cunea* Drury. Bulletin No. 60, Bureau of Entomology, page 41, U. S. Department of Agriculture, 1906. (10 pages, 1 plate.)

Beutenmüller, William, Bulletin American Museum of Natural History, Vol. X, page 376, 1898. Brief description and illustration of adult.)

Britton, W. E., Report Connecticut Agricultural Experiment Station, page 270, 1901 (Brief account of prevalence in 1901); page 213, 1904 (Note on insect being partially double-brooded in Connecticut).

The Fall Web-worm Partially Double-brooded in Connecticut. Bulletin No. 52, page 42, Bureau of Entomology, U. S. Department of Agriculture, 1905 (Brief note).

Felt, E. P., Insects Affecting Park and Woodland Trees, I. page 142, 1905 (Full illustrated account).

Howard, L. O., Three Insect Enemies of Shade Trees. Farmers' Bulletin No. 99, page 20, U. S. Department of Agriculture, 1899 (Brief illustrated account).

Kirkland, A. H., The Shade-Tree Insect Problem. An address delivered before the Mass. State Board of Agriculture, Dec. 3, 1901. Reprint page 18. (Brief illustrated account.)

Riley, C. V., Our Shade Trees and Their Insect Defoliators. Bulletin No. 10, Division of Entomology, U. S. Department of Agriculture, page 33, 1887 (Full illustrated account).

THE HICKORY TUSSOCK MOTH, *HALISIDOTA CARYAE* HARRIS, AND OTHER CLOSELY ALLIED SPECIES.

The report of this Station for 1907, contained on page 332 a brief notice of the hickory tussock moth, and illustrations were given on plate XV. During the past ten years this insect has had its ups and downs, but in 1917 it seemed to be more abundant than for many years. Late in the summer the caterpillars were seen crawling about on walks, fences, trunks of trees, etc., seeking a place to pupate. Associated with the hickory tussock moth caterpillars were the caterpillars of the white-marked tussock moth and many larvae of the tessellated tussock moth, *Halisidota tessellaris* S. & A. The latter is not as common normally in Connecticut as *caryae* but in some localities in 1917 it approached it closely in abundance. The larvae of both species are shown on plates XIX and XX. Plate XX, c, shows the cocoons, probably of both species, on the trunk of a sugar maple tree growing along one of the streets in New Haven.

These tussock moths belong to the family *Arctiidae* and are closely related to the fall web-worm described on page 322 of this report. There are three species in Connecticut: *Halisidota caryae, H. tessellaris* and *H. maculata.* Though the first two are fairly common, *maculata* is rather rare about New Haven but is said to occur more abundantly farther north. *Maculata* feeds on willow, poplar, alder and oak; *caryae* feeds on oak, elm, maple, hickory, walnut, poplar, willow, ironwood, hornbeam, chestnut, linden, locust, apple, cherry, larch, etc.; *tessellaris* is known to feed upon maple, oak, elm, beech, June berry, locust, hornbeam, hickory, walnut, ash, sycamore, witch-hazel, huckleberry, chestnut, willow, poplar, tulip tree, sweet gum and linden. It will be seen from the list given above that these tussock moths are somewhat general in their feeding habits and it would not be strange to find them devouring almost any kind of foliage.

The adults of all three species appear in June and July and the females lay their eggs on the under side of the leaves of their host trees. The hickory tussock moth deposits eggs in a patch about an inch broad. The young larvae feed gregariously at first and greatly resemble those of the fall web-worm, but as they increase in size they take on characteristic markings with each moult. Next to the last instar, they are covered with white hairs prettily

ornamented with black spots, and with two pencils of black hairs near each end of the body, as shown on plate XIX, b. In the last caterpillar stage, just before pupation, there is a continuous black stripe along the back with the black pencils as described above. The caterpillar is then about one and one-half inches long, and is shown on plate XIX, b.

The caterpillar of the tessellated tussock moth varies from gray to yellow, and does not have such a prominent black stripe along the back. On the second segment back of the head, there is on either side a lateral black pencil with two white ones under it. On the third segment there is a similar black pencil with one white one under it. This larva is about one and one-fourth inches long and is shown on plate XX, b.

The adults of both species are about the same size, and have a wing-expanse of about two inches. *Caryae* has light brown fore wings marked with silvery white spots; rear wings nearly white, being light brown or yellowish. Body buff or light brown. *Tessellaris* has both wings of nearly the same color, light brown, semi-transparent. The fore wings are marked transversely with inconspicuous blocks of darker color; rear wings without markings. Body buff or light brown. *Maculata* resembles *caryae* but has light brown instead of white markings on the fore wings.

The cocoons are ash gray and are formed on the trunks of trees, sides of buildings, fences, walls, etc. There is only one brood each year and the winter is passed in the cocoon.

A description of all stages, and illustrations of the white-marked tussock moth (*Hemerocampa leucostigma* S. & A.) will be found in the Report of this Station for 1916, page 105.

Wherever these tussock moths become so abundant as to defoliate trees, the remedy is to spray with lead arsenate, using three pounds of the paste in fifty gallons of water. Properly sprayed orchards will not be injured. In addition to spraying with poison, the caterpillars can be killed when found, and the cocoons can be removed from the trunks of trees during the winter months.

THE WALNUT CATERPILLAR.

Datana integerrima Gr. & Rob.

This caterpillar feeds in clusters on black walnut, butternut and hickory, often defoliating trees, and was particularly abundant

in the State in 1917. It has been mentioned in preceding reports of this Station as follows: 1901, page 275 (brief note); 1905, page 257 (bare mention); 1906, page 298 (bare mention); 1914, page 191 (brief note with one illustration); 1916, page 140 (brief note). The purpose of this article is to give a more exte ded account of the insect so that property owners and caretakers will recognize it. Several times this insect has been reported to the Station as being the gipsy moth.

On August 16, the entomologist was called to Clintonville, where several black walnut and hickory trees were being defoliated. One large black walnut was about half stripped and the leaves were fast disappearing. Nearly every branch contained one or more clusters of caterpillars, all eating away on the leaves. A small tree of the same kind nearby had been wholly stripped. Hickory trees along the road not far away were also infested, some branches being then denuded.

Caterpillars were received on black walnut from Meriden, August 10; East Haven, August 13; Wethersfield, August 29; and on hickory, Wethersfield, August 30.

The caterpillars are gregarious and may be seen feeding in clusters near the ends of the branches. When full grown they are about two inches long, black, and covered with whitish hairs. The appearance of a single caterpillar is shown on plate XXI, b. Just before pupating the caterpillars separate and crawl up and down the trunks of the trees and along the ground. One often sees them crossing the highway and wonders where they are going; probably either seeking more food or a place to pupate.

Before reaching maturity these caterpillars have the habit of congregating in masses on the trunk or larger branches for the purpose of moulting. The discarded skins remain on the tree making a patch of fur, as shown on plate XXI, d. All larvae of the genus *Datana* are gregarious, and when disturbed elevate their heads and tails in a characteristic and peculiar manner, as shown on plate XX, d. The chrysalid is a naked brown pupa formed in the ground where the species passes the winter. There is only one brood each year.

The adult is a tan-colored or reddish-brown moth with a wing-spread of about two inches. The forewings are crossed with more or less distinct lighter and darker bands. A patch on the thorax is of a beautiful and brilliant mahogany red. The adult, natural size, is shown on plate XXI, a.

Though this insect is not of tremendous economic importance, it is conspicuous and people wonder what it is. Moreover, it works very rapidly and the trees attacked are soon stripped; but this stripping, coming as it does so late in the season, does not seriously impair the vitality of the trees, which may put out leaves the next season as if nothing had happened. Of course it makes the trees unsightly and if followed year after year would soon weaken, and perhaps finally kill them.

Spraying the foliage with lead arsenate at the usual strength will prevent injury or will kill the caterpillars which feed upon the leaves.

The caterpillar is parasitized by a small, four-winged fly, *Meteorus communis* Cresson.

As these caterpillars are conspicuous and feed in clusters on the branches, they can easily be removed and destroyed, especially on small trees within reach of the ground. The masses of moulting caterpillars can also be crushed.

THE YELLOW-NECKED CATERPILLAR.

Datana ministra Drury.

Closely allied to the walnut caterpillar, but differing from it by being more distinctly yellow and striped, is a species common on apple, especially young trees, in August and September, known as the yellow-necked caterpillar, *Datana ministra*. This caterpillar, like the walnut caterpillar, feeds gregariously, each egg-cluster hatching into a colony. The caterpillars continue to feed together until they strip their branch or tree and seek more food, or until they moult or transform to the pupa stage.

The yellow-necked caterpillar was very abundant in 1917, and we found colonies in nearly every nursery where apple stock is grown. In newly-set orchards, it always appears and alarms the owner by proceeding to strip some of his choicest trees. It occasionally feeds upon other kinds of trees. Thus on August 9, we received specimens on cherry from New Britain; on apple from Southbury, August 10; Durham, August 15; New Haven and Hamden August 16, on willow, Stonington, September 10. Assistants from this office observed it in Ellington, Manchester, Durham, Wallingford, New Haven, New Canaan, and probably in many more towns when inspecting nurseries.

When fully grown the caterpillar is about two inches in length, striped lengthwise with yellow and black, the stripes being nearly equal in breadth, except for a broader black stripe along the back. Head and legs black and shining. An orange-yellow cross band next the head doubtless gives this caterpillar its name. The body is sparsely covered with rather short and weak light-colored hairs; it does not have the distinctly hairy appearance of the walnut caterpillar nor does it leave hairy patches on the trees where moulting takes place. Like the walnut species, however, when disturbed it elevates head and tail and would thus be recognized as a *Datana*. The adult closely resembles that of the walnut caterpillar and only specialists can separate them. Larvae and adults of both sexes are shown on plate XXII. There is only one generation each year, and it is as a cocoon in the ground that it passes the winter. Apparently this species is not strongly parasitized but *Apanteles lacteicolor* Viereck and *Heteropelma datanæ* Riley have been reared from *Datana* and may be expected to attack it.

What has been said of injury and control measures relating to the walnut caterpillar applies also to this species, except that on one's pet apple trees in the orchard the caterpillars are sooner noticed, and the discovery is made with greater alarm. But here, also, as it is chiefly young trees that are attacked, it is easier to remove and destroy the colonies. Spraying also would be easier on young and small trees. By no means should young orchard trees be allowed to become stripped. In order to make a good orchard, all trees should be kept free of pests and constantly growing and thrifty. Stripping will check their growth if it does not greatly weaken them, and to permit it is indefensible. All such trees should be sprayed each year with lead arsenate, and a close watch should also be kept, and if a colony of these caterpillars be noticed, drop all other work until the pest has been eradicated.

THE RED-HUMPED CATERPILLAR.

Schizura concinna S. & A.

Belonging to the same family (Notodontidae) as the walnut caterpillar and the yellow-necked caterpillar, but to a different genus, is another peculiar and characteristic defoliator of young

apple trees in late summer, known as the red-humped caterpillar, *Schizura concinna*. This name was given it because the prominent fourth segment from the head is bright coral red in color, as is also the head. The body of the caterpillar is narrowly striped lengthwise with orange, brown and white. Nearly all the segments bear short and rather stout black spines or protuberances projecting upward on the back. These are longest in the vicinity of the "hump" or fourth segment. Length about one and one-half inches.

The adult moth has a wing-spread of about one and one-half inches. The female is not conspicuously marked but both front and rear wings are grayish brown, the fore wings shading costally into a lead gray with small apical black spots. The male is much more prominently marked, the fore wings being brown and cream, with a shading of gray on the front margin, especially near the apical spots. The rear wings are cream with a black spot near the anal angle. Body of both sexes gray. Both larvae and adults are shown on plate XXIII. There is one generation each year, the insect hibernating in a slight cocoon under rubbish on the ground. This insect is perhaps less common than the yellow-necked caterpillar, and though it feeds gregariously, the caterpillars do not form such conspicuous clusters on the twigs. They do not elevate their heads when disturbed, like *Datana*, but their tails are elevated all of the time when they are feeding and crawling about. Like the yellow-necked caterpillar, this species is found upon young apple trees in nurseries and in newly-set orchards, but is by no means confined to the apple. It may feed upon almost any plants of the family Rosaceae.

The caterpillars are parasitized by an ichneumon or four-winged fly, *Campoplex* (*Ameloctonus*) *oedemisiae* Ashmead, which was reared in Connecticut from larvae collected at New Canaan, September 22, 1905, by B. H. Walden. Parasitized larvae are shown on plate XXIII, b. Spraying with lead arsenate is the remedy unless destroying by hand can be practiced.

SOME INSECTS INJURING STORED FOOD PRODUCTS IN CONNECTICUT.*

The importance of growing more food for the people of this

* This paper was published as Bulletin 195, and distributed in August. It is here reprinted with appropriate emendations.

country cannot be over-emphasized, and the various efforts along this line and the publications giving information regarding methods are all praiseworthy. Nevertheless, it is perhaps equally important to conserve the food supplies already grown and stored. It has been estimated that insects take an annual toll of about five per cent. of the value of the stored food products, amounting to $200,000,000.00 each year, in the United States. Most of this loss is wholly preventable if attention is given the matter at the right time, and there is no time when control methods can be enforced with greater profit to the owner, or with greater benefit to our country and to mankind than the present.

The object of this paper is to place before the people of Connecticut a brief account of the principal insects attacking and injuring stored grains and food products in the state, and to suggest methods of controlling them. The accompanying plates are for the purpose of illustrating the text and of giving an idea of the general appearance of the insects.

These insects belong in two large natural groups: the Beetles (Coleoptera) and the Moths (Lepidoptera). The principal features of each are given to enable the reader to identify the species, but as control measures are similar for all, information on this point is given in a separate chapter on page 339 of this report.

THE GRAIN BEETLES.

The Common Meal Worm, *Tenebrio molitor* Linn.

In and around the bottoms of bins and barrels where corn meal, flour, or other cereals are stored, one often finds yellow larvae about an inch in length and resembling wire worms. These feed upon the meal and are called meal worms.

The adult is a shining, black or dark brown beetle, somewhat more than half an inch in length, with thorax rather finely punctured and wing-covers longitudinally striated or grooved. The beetle lays its white eggs in the meal, usually in masses, with a juice or sticky material which causes the meal to adhere to the eggs. The eggs hatch in about two weeks and the larvae feed upon the meal for three months or longer before pupating. The pupal stage requires about two weeks, and normally there seems to be but one generation each year. The adults mostly emerge

in the spring, but where the meal is stored in the house, or in a heated building, they may appear at any time of the year. This insect is shown on plate XXIV, b.

The Darker Meal Worm, *Tenebrio obscurus* Fabr.

This insect is much like the preceding except that the larvae are darker in color and the adult beetles are dull instead of shiny. The life history and injuries are similar and both often occur in the same place.

The treatment is also the same for both species, viz.: fumigating with carbon disulphide or heating the meal in an oven for a short time.

The Cadelle, *Tenebrioides mauritanicus* Linn.

The larva of this beetle is dirty-white, with head, prothorax and tip of abdomen dark brown, and when fully grown it measures about three-fourths of an inch in length. It has the habit of tunneling into wood to make its cocoon, at least when soft pine is available. The pupa stage evidently lasts three or four weeks.

The adult beetle is brown and shiny, and about three-eighths of an inch long. It lays white eggs which are a trifle over a millimeter long and one-fourth as thick.

There is a single generation annually, and the cadelle feeds on various kinds of stored foods and plant products and is also partially predaceous, as Chittenden* states that both larvae and adults attack and destroy other grain insects which they encounter. Nevertheless, the cadelle is capable of causing considerable injury and the treatment is the same as for the other meal worms. The larvae of the cadelle have been reported from many unexpected places, such as in sugar, in bottles of milk, in powdered hellebore, and boring through the parchment paper of jars of jams and jellies. In some of these places they probably occurred accidentally. Larva and adult are shown on plate XXIV, d.

The Pea Weevil, *Bruchus pisorum* Linn.

The adult beetle is about one-fifth of an inch long, and the wing covers are marked with small black and white spots. It

* F. H. Chittenden, Farmers' Bulletin No. 45, U. S. Department of Agriculture, page 19, 1896.

lays eggs singly on the outside of the green pods in the field, and the larva tunnels through the pods and into one of the green peas. The insect does not mature until the peas have ripened and have been harvested and placed in storage. Then it is common to find a single round hole in a pea where the adult has emerged. Sometimes nearly every pea has a hole in it, and many larvae are unquestionably cooked and eaten in green peas; but the insect does not go on breeding in dry stored peas, there being only one brood each year.

The pea weevil is more serious in the Middle Atlantic than in the Northern States, but it is present in Connecticut. In the Southern States it is claimed that late planting brings comparative immunity from attack but in the writer's experience late planted peas seldom produce a satisfactory crop here. Hence it is better to treat the seed soon after harvesting, and to make allowance in planting for a certain percentage of injured seed. This insect is shown on plate XXIV, e.

The Common Bean Weevil, *Bruchus obtectus* Say.

This is probably the greatest enemy of beans in Connecticut, and though in size somewhat smaller than the pea weevil and resembling it in color and markings, it differs from it by continuing to breed in the dry, stored seed. There are six generations annually in the District of Columbia, and a smaller number in the northern states. Stored beans are often entirely destroyed, or at least rendered unfit for planting, or as food for man or beast. The beans often have several holes in each where the adults have emerged, and as many as 28 have been found in a single seed. Severely weeviled beans are almost useless for planting, but the good seed may be separated from the infested seed by throwing into water. The injured seed will float and may be discarded. This beetle and its work are shown on plate XXV.

The Four-Spotted Bean Weevil, *Bruchus quadrimaculatus* Fabr.

This species is somewhat more slender than the preceding and has different markings. Its habits and life history are similar and the same control methods may be practiced.

The Drug Store Beetle, *Sitodrepa panicea* Linn.

Of all the insects attacking stored food products, perhaps none is more cosmopolitan or feeds upon a greater number of different kinds than the drug store beetle. It is a common pest of all kinds of stored vegetable foods and may be found in breakfast foods, or the dried roots, stems, bark, and seed capsules commonly called spices. It feeds also on the parts of plants used as drugs, often eating those which are bitter and poisonous to man. It has been recorded as attacking forty-five different drugs. It is now distributed throughout the civilized world, and four or five generations may occur in a year, especially in a heated building.

The beetle is about one-tenth of an inch in length, covered with a silky pubescence, and reddish-brown in color. The wing-covers are longitudinally striated and the antennae terminate in three long segments forming the so-called "club." The larvae are white, with dark mouth parts, and assume a curved attitude when at work in their burrows. The adult is shown on plate XXIV, a.

The Confused Flour Beetle, *Tribolium confusum* Duv. and The Rust-red Flour Beetle, *Tribolium ferrugineum* Fabr.

The confused flour beetle has been known to occur in this country for nearly twenty-five years and has caused injury throughout the land. It attacks seeds, stored cereals and other starchy foods and drugs, and is a pest in flour and grain mills.

The adult is a flattened brown beetle, less than a sixth of an inch in length. There may be as many as four generations annually in a heated storehouse.

The rust-red flour beetle closely resembles the preceding, but is not nearly as common in Connecticut. It is a pest in the Southern States and is often shipped north in rice or other starchy food products.

The Saw-toothed Grain Beetle, *Silvanus surinamensis* Linn.

One of the most common beetles in grain and stored food products is the saw-toothed grain beetle. It is less than an eighth of an inch long, flattened, grooved longitudinally, with teeth-

like projections on the sides of the thorax, and brown in color. The larva is white, extremely active, and makes its pupa case on some convenient surface by joining together particles of the infested material with some adhesive substance which it secretes.

There are probably four or five generations each year, and the beetles eat through paper bags and pasteboard boxes to reach foodstuffs inside. Though perhaps preferring farinaceous foods, this beetle often infests fruits and almost all kinds of stored food products. This beetle and its injury to corn are shown on plate XXVII, a and c.

A flat, smooth, reddish-brown beetle, still smaller than the preceding, is occasionally found infesting wheat bran or other cereals. This is *Læmophlæus pusillus* Schr., one of the minor pests but nevertheless capable of causing much injury.

The Granary Weevil, *Calandra granaria* Linn.

Both this weevil and the following belong to the family Calandridae or snout beetles. The adult is a shiny reddish-brown snout beetle nearly an eighth of an inch in length, with a long proboscis. The larva is a legless grub. Both adult and larva feed upon the kernels of the grain. There are four or five generations each year in the vicinity of Washington, D. C., and more farther south. It attacks and injures maize and all of the small grains.

The Rice Weevil, *Calandra oryzae* Linn.

This species resembles the preceding except that it is dull brown instead of shining, and the thorax is more densely pitted. There are four more or less distinct red spots on the wing-covers. This insect is often found in the field and takes its name from the rice which it infests. Its habits and life history are otherwise similar to the preceding. It is shown on plate XXIV, c.

THE FLOUR AND MEAL MOTHS.

The Indian Meal Moth, *Plodia interpunctella* Hubn.

Considerable damage is done each year in mills, granaries, seed warehouses, etc., by the Indian meal moth, which is also a common pest of the household, as it attacks nearly all kinds of

vegetable food products. Each year some food material infested by this insect is brought to the writer's attention. In 1905 some large seed warehouses near New Haven were found infested, and one room was fumigated with hydrocyanic acid gas. This treatment killed the larvae crawling about, and those at work near the outside of the bags, and at first seemed to be effective. Later, however, living larvae appeared from inside, showing that the gas did not penetrate far into the mass of grain.

The larvae web together the grain and flour, especially around the outside. One 100-pound bag of corn was emptied and seven pounds adhered to the bag. The kernels were eaten at the embryo, and are shown on plate XXVII, d.

The eggs are small, white, and laid singly or in groups, and each female may lay as many as 350. The larva is whitish, and spins a silk thread wherever it feeds and travels, and the web

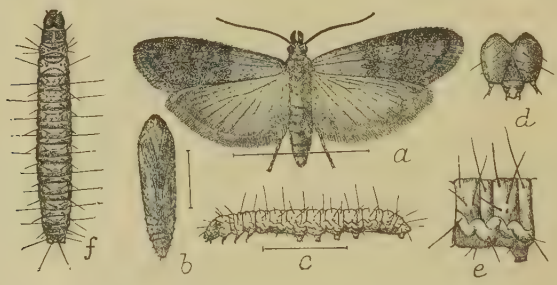

Figure 4. Indian meal moth. *a*, adult; *b*, pupa; *c*, larva, side view; *d*, head of larva, front view; *e*, first abdominal segment of larva; *f*, larva, dorsal view—all greatly enlarged. (After Chittenden, Bur. of Ent., U. S. Dept. of Agriculture.)

holds together the particles of food material. Pupation takes place in a silken cocoon-like web from which the moths emerge. From four to five weeks only are required for a generation to develop. In a heated building this insect will breed throughout the year.

The adult is a small moth having a wing-spread of about five-eighths of an inch; forewings whitish at base with distal half reddish-brown, as shown in figure 4.

The Mediterranean Flour Moth, *Ephestia kuehniella* Zell.

This insect is regarded by Chittenden as the most important of all the species infesting flour and grain mills. It has been reared from flour in New Haven and has been taken at Branford. In life history and injury the Mediterranean flour moth resembles the Indian meal moth, and in heated buildings five or six broods may occur each year. The moth is shown on plate XXVI, c. It is larger than the Indian meal moth and has a wing-spread of about an inch. The forewings are dull lead-gray, crossed by zigzag darker lines or bands. Not only does this insect injure flour and grain but also feeds upon almost any kind of stored vegetable food products.

The Meal Snout Moth, *Pyralis farinalis* Linn.

This insect infests flour, meal, and other stored food products, though not as serious a pest as the Indian meal moth or the Mediterranean flour moth.

The larvae have the habit of constructing long tubes by binding together with silk small particles of the meal or food material. In these tubes the larvae live and hide until fully grown when they leave the tubes and spin their cocoons, usually in or just outside of the infested material. There are probably three or four generations each year, though further studies are needed in this latitude to determine this point.

The adult has a wing-spread of about an inch, is light brown, with thorax, base and apex of fore wings darker brown, and with whitish wavy lines crossing front and rear wings, as shown on plate XXVI, a.

THE GRAIN MOTHS.

The Angoumois Grain Moth, *Sitotroga cerealella* Oliv.

This destructive insect was known in France nearly two hundred years ago, and was somehow brought to this country in the early colonial days, and became established in North Carolina and Virginia. Since then it has spread northward to Massachusetts, New York and Michigan and throughout the southern states, where it does much damage. The writer first noticed it in Connecticut nearly twenty years ago, and has run across it a

number of times since. It is primarily a pest of stored grains, especially corn on the ear, which if infested soon appears as shown on plate XXVII, b. The emerging moths leave small circular holes in the kernels. Infested grain is injured not only for seed, but also for feeding purposes; as it has been estimated that it loses within six months 40 per cent. of its weight and 75 per cent. of the starchy matter. The moth lays whitish eggs on the kernels of corn, and they soon turn to a pale reddish color and hatch in five or six days. Two or more larvae may occupy a single kernel of maize, though only one occurs in a grain of wheat. The adult is a light, grayish-brown moth, having a wing-expanse of about half an inch, somewhat resembling a clothes moth. Out of doors in the southern states there are at least four broods annually and the larva passes the winter in kernels of grain. In this climate it breeds only in stored grain, and in heated buildings this goes on continuously, there probably being five or six generations, depending upon the temperature.

The European Grain Moth, *Tinea granella* Linn.

Compared with the Angoumois grain moth this moth is of secondary importance, and seems to be not especially destructive in the United States. It infests all kinds of cereals, and as each larva may pass from one kernel into another, webbing them together until twenty or thirty grains are spoiled, it is apparent that considerable injury must result.

This moth was first found in Connecticut, in 1906,* in a seed warehouse in Milford. It is now distributed throughout the northern states.

The adult is a slender moth with a wing-spread of half an inch, creamy white mottled with brown. This moth and its work are shown on plate XXVI, b and e.

OTHER INSECTS OCCASIONALLY ATTACKING FOODS.

The large cabinet beetle, *Trogoderma tarsale* Melsh., frequently injures seeds and is shown on plate XXVI, d. The small cabinet etle, *Anthrenus verbasci* Linn., and the black carpet beetle,

* Report of this Station for 1906, page 305.

Attagenus piceus Oliv., occasionally attack and injure food products, though the latter is a more important pest of clothing.

The larder or bacon beetle, *Dermestes lardarius* Linn., the red-legged ham beetle, *Necrobia rufipes* Fabr., and certain species of mites of the genus *Tyroglyphus* sometimes injure dried meats, cheese, dried fruits, cereals, etc. The cigarette beetle, *Lasioderma serricorne* Fabr., though primarily a pest of tobacco, feeds upon the spices, rice, figs and many other food products. Then the cheese skipper, *Piophila casei* Linn., which occurs everywhere, often attacks cheese and the larvae may be found tunneling in it. Cheese should be kept covered and should be examined every day in warm weather. Hams and other kinds of meat are infested only in certain portions which can be cut off and the remainder used for food.

A species of book-lice, *Troctes divinatorius* Müll. (order Corrodentia), was found eating corn at the Station in 1900. The sample was stored in a ground glass-stoppered jar. The outer surface of the kernels was wholly eaten off, so as to render the variety wholly unrecognizable.

Cockroaches and ants are also frequently injurious in pantries and storehouses. The former are usually susceptible to the influence of powdered borax, and ants can usually be driven away by scattering naphthalene flakes about on the floor and shelves, especially where the ants have their runways.

The other insects mentioned in this chapter without control methods may be killed by heat or by fumigation.

CONTROL METHODS.

The chief methods for preventing damage by the insects mentioned in the foregoing pages are: the use of high and low temperature, air-slaked lime, pest-proof packages and fumigation.

Temperature.

Temperature is recognized as an important factor in insect development, and often determines in a measure the number of annual generations of certain species. Extremes in temperature are sometimes employed for the control of insects.

Heat.

It has long been known that heat will kill insects, and one of the simplest methods of destroying them in small packages of flour or other food products is to heat it in the oven for an hour or so. Following this idea Professor George A. Dean started some experiments in Kansas in 1910 to determine the fatal high temperatures for certain grain-infesting insects, and found that few insects can withstand a temperature of from 118°-125° F. for any length of time. In a mill there are accumulations of meal and floor on the floor, beams, machinery, and in the corners everywhere in which insects can breed. To keep a mill free from this accumulation and absolutely clean is almost an impossibility. By the use of heat, however, the insects can be killed from time to time without serious inconvenience, without shutting down the mill, and without great expense. It requires extra steam pipes sufficient to raise the temperature to about 120° F., and to keep it there for a period of five or six hours to allow the heat to penetrate the bins and bags of grain. Professor Dean has published three papers on this subject,* and any one interested should write to him for further advice.

Any grain or seeds which are intended for planting should not be heated to a point much greater than 130° F. as there is danger of injuring the vitality, which with some seeds ceases if the temperature approaches 150° F.

Any product to be used for food will not be injured by this heating method and even the eggs and larvae, as well as the adult insects, are killed by it.

Cold.

A low temperature is not so frequently used for destroying insects, yet it has been known for a long time that insect development is arrested or suspended altogether in cold storage.

Mr. J. A. Manter† of Storrs, Conn., states that the bean weevil will not breed in cold storage and suggests that beans be stored

* Journal of Economic Entomology, Vol. IV, page 142, 1911; Vol. VI, page 40, 1913. Kansas Agricultural Experiment Station, Bull. 189, July, 1913.

† Journal of Economic Entomology, Vol. X, page 193, 1917.

in unheated buildings. This idea may be carried out in practice with certain other stored food insects but the exact temperatures have not yet been determined for all species.

Air Slaked Lime.

A very simple and promising treatment to prevent weevil injury to peas, beans, cow peas and possibly to other kinds of seeds has recently been discovered by Mr. Z. P. Metcalf* of the North Carolina Station. This consists of applying air-slaked lime to the seeds, using one part by weight of lime to two parts of seeds when placing the crop in storage. For small quantities, say less than a half peck, Professor Metcalf advises the writer in a letter that four parts of lime should be used to one part of seeds; for quantities between a half peck and three bushels, use equal amounts of lime and seeds. The quantity of seeds to be stored thus influences the effectiveness of the treatment and necessitates greater proportions of lime for small quantities. In time this method may be found applicable to other kinds of seeds and against other insects. It has the advantage of being harmless to seeds and to the operator, as well as being convenient to procure and relatively inexpensive. Professor Metcalf is now completing further tests of this material. Plate XXV, c, shows untreated seeds and those treated with lime.

Pest-proof Packages.

Materials sealed in glass or metal containers are usually safe against insects as long as they remain unopened. We have a number of records showing that the smaller beetles, like the saw-toothed grain beetle, will enter poorly stoppered glass bottles and jars and even tin-stoppered cans. The material is of course often infested before placing in the containers.

Mr. William B. Parker of the U. S. Bureau of Entomology has made investigations and suggests† a sealed paper carton for packing cereals which are to be placed upon the market. While this may prevent infestation in stores and warehouses, in the

* Journal of Economic Entomology, Vol. X, page 74, 1917.

† Bulletin 15, U. S. Department of Agriculture, 1913.

household many opened packages often attract insects, and if stored for a long time no paper package is insect-proof. Hence other methods must be resorted to, especially in dwelling houses, to keep the foodstuffs free from insect attack.

Fumigation.

Fumigation has long been practiced to kill insects in seeds and food substances. For this purpose two materials are commonly used, viz., carbon disulphide and hydrocyanic acid gas.

Carbon Disulphide (Bisulphide).

This is a colorless, ill-odored liquid which volatilizes at air temperatures, more readily in warm weather, and the fumes are deadly to all forms of insect life. Carbon disulphide may be purchased in pound bottles from any wholesale druggist, and as it is inflammable when the fumes are mixed with air, it should not be used by any one smoking, or at night with oil or gas lights near. As the fumes are heavier than air the liquid should be placed on top, rather than at the bottom of the grain, seeds or material to be treated. It should also be placed in a shallow dish to facilitate volatilization. The quantities used are about one pound to each 40 bushels of seeds, or to each 100 cubic feet of space. In a tight barrel containing grain or seeds, about one-half cupful of the liquid should be placed in a saucer on top of the seeds, the barrel covered tightly and allowed to remain all day or longer. For smaller receptacles, use proportionate quantities of the liquid. Carbon disulphide is more convenient, less dangerous to the operator, and its fumes penetrate better than hydrocyanic acid gas. A recent bulletin by Dr. Hinds* contains much information about carbon disulphide and may be obtained by applying to the U. S. Department of Agriculture, Washington, D. C.

Hydrocyanic Acid Gas.

This is a deadly poisonous gas generated by putting together cyanide, sulphuric acid and water. Potassium cyanide was

* Farmers Bulletin 799, U. S. Department of Agriculture, June, 1917.

formerly recommended, but sodium cyanide is now the cyanide of commerce and is effective. The quantities for 100 cubic feet of space are as follows:

Sodium cyanide	1 oz.
Commercial sulphuric acid	2 fluid ozs.
Water	4 fluid ozs.

If a room is to be fumigated its cubic space must be ascertained and the chemicals carefully weighed or measured. It must be made reasonably tight, and provision must be made for opening from the outside at least one window or door, besides the exit. The generating jar may be earthen or stoneware but never metal. The acid may be diluted with the water, the cyanide placed in a paper or cheesecloth bag, and when all is ready the operator should drop the bag into the jar and with bated breath retire at once and close and lock the door. One full inhalation of this gas will drop a man, and no carelessness should be permitted. The house or room should be exposed for at least two hours and may remain closed over night or over Sunday. The fumes do not penetrate as well as those of carbon disulphide.

Recently Mr. E. R. Sasscer of the U. S. Department of Agriculture has devised an apparatus for fumigating cotton bales, bags of seeds, etc. By removing the air and forcing the gas into a partial vacuum thus created, most insects are killed with a half hour exposure.* On account of the danger, trouble of generating, etc., the average farmer and householder will seldom use hydrocyanic acid gas and will find carbon disulphide or heat sufficient to meet his needs.

SUMMARY.

Much damage results each year in Connecticut to cereals and other stored food products from the attacks of insects. This injury has been estimated at five per cent of the total value of the products, or $200,000,000.00 each year for the United States, and is wholly preventable.

The insects are chiefly beetles (*Coleoptera*) and moths (*Lepidoptera*). The former include the meal worms, cadelle, pea and bean weevils, drug store beetle, confused flour beetle, rust-red flour

* Bulletin 186, U. S. Department of Agriculture, 1915.

beetle, saw-toothed grain beetle, granary weevil, rice weevil, large and small cabinet beetles, black carpet beetle, larder beetle, red-legged ham beetle, and cigarette beetle. The latter include the Indian meal moth, Mediterranean flour moth, meal snout moth, Angoumois grain moth, and European grain moth. Other insects like the cheese skipper (a fly), a book louse, ants, cockroaches, and even mites occasionally cause damage.

The most important of these pests are described briefly in the preceding pages.

Most of these insects may be destroyed by raising the temperature to a point between 120° and 130° F. for five or six hours. The vitality of seeds is endangered if the heat approaches 150° F. but the material would not be injured for food.

Food kept in cold storage will not be injured by insects.

Various pest-proof packages have been devised, but food often becomes infested in them, and no package is pest-proof after the seal has been broken.

Air-slaked lime applied to seeds when placed in storage will prevent most of the damage caused by the pea and bean weevils. The proportions are as follows: For small quantities, say less than a half peck, four parts of lime to one part of seeds; between a half peck and three bushels, equal parts of lime and seeds; for greater quantities, one part of lime to two parts of seed.

Fumigating with carbon disulphide, using a half cupful to a barrel, will rid the material of insect life. This liquid should be placed on top of the infested material, and should not be used near a fire as it is inflammable. The container should be tightly covered for twenty-four hours or longer.

Hydrocyanic acid gas may also be used but is not advised except in particular cases, as it is deadly to breathe and does not penetrate masses of flour and grain readily. Seeds and food materials if thoroughly aired are not injured by carbon disulphide or hydrocyanic acid gas, either for food or for planting.

For more detailed information on this subject the reader should refer to pages 330 to 343 of this Report.

MOSQUITO WORK IN CONNECTICUT DURING 1917.

By B. H. Walden.

Legislation. The State law providing for the elimination of mosquito breeding places, Chapter 264, Public Acts of 1915 (See 15th Report Conn. State Entomologist, page 141, 1915), was amended by the 1917 Legislature to read as follows:

Chapter 402.

AN ACT AMENDING AN ACT PROVIDING FOR THE ELIMINATION OF MOSQUITO BREEDING PLACES AND AREAS.

Be it enacted by the Senate and House of Representatives in General Assembly convened:

Section 1. The director of the Connecticut Agricultural experiment station may make rules and orders concerning the elimination of mosquitoes and mosquito breeding places, and he or his agent may enter upon any swamp, marsh or land to ascertain if mosquitoes breed thereon, or to survey, drain, fill or otherwise treat or make any excavation or structure necessary to eliminate mosquito breeding on such land.

Sec. 2. Whenever funds have been provided by the town, city or borough, in which any such swamp, marsh or land is located, or by voluntary contribution, sufficient to pay three-fourths of the cost, as estimated by said director, of work of eliminating mosquitoes or mosquito breeding on such swamp, marsh or land, and moneys appropriated by the state are available sufficient to pay one-fourth of said cost, or whenever funds have been provided from other sources than the state sufficient to pay all of said cost, said director may order the execution of said work upon notice as herein provided. At least thirty days before commencing such work, said director shall file a copy of such order, with a description of the place or area affected and a statement of the proposed plan thereof, in the town clerk's office in each town in which such place or area is located. Said director shall publish a copy of such order once each week for two successive weeks in some newspaper having a circulation in the town or towns in which such place or area is situated, and shall mail a copy of such notice, postage prepaid, by registered mail, addressed to each record owner of land whose name and address may be ascertained by a reasonable inquiry from the assessors of the town in which such land is situated. Said director may, and upon application of any person affected by such order or plan, within thirty days after such publication, shall assess benefits received and damages sustained by the owner of any such land. Such assessment shall be filed by said

director with the clerk of the superior court of the county within which the land affected is located, and said clerk shall give notice of such assessment to each such property owner, by mailing to him a copy of such assessment, postage prepaid. Any person claiming to be aggrieved because of such order or proposed plan or such assessment may, within ten days after notice, apply to the superior court in the county in which such land is situated, or any judge thereof, for relief, and said court or such judge may, after notice to said director and parties applying for relief, and hearing thereon, make any proper order concerning such order or proposed plan, or make a reassessment of benefits and damages. Said court or judge may view the land claimed to be affected by such order or plan and may take any evidence in its opinion material. The order, plan and assessment as hereinbefore provided for shall be conclusive upon all parties affected thereby, and the state treasurer shall pay to any such owner the damages assessed by said director or by said court or judge, as the case may be, upon certification of the amount by the clerk of said court. Benefits assessed as herein provided shall be collected by said treasurer and shall constitute a lien upon the land against which the same were assessed until the amount thereof has been paid with interest at the rate of six per centum per annum, which lien may be continued by filing in the office of the town clerk of the town where such land is situated a certificate thereof within sixty days after the assessment of the same, and such lien may be foreclosed or the benefits secured thereby collected in any other proper form of action. The town wherein such land is located shall reimburse the state for three-fourths of the damages assessed and paid as herein provided, and the state treasurer shall pay to any such town one-fourth of all benefits received. All amounts collected from towns under the provisions of this section may be expended for the purposes stated in said section. The pendency of any application for the assessment of benefits and damages shall not prevent or delay the execution of the work for the elimination of mosquitoes or mosquito breeding. Upon the completion, to the satisfaction of said director, of any such work one-fourth of the cost of which is payable by the state as hereinbefore provided, said director shall certify to the comptroller, with proper vouchers, the amount of such costs, and the comptroller shall draw his order on the treasurer for such sum as, with any amounts advanced on account thereof as hereinafter provided, shall amount to one-fourth of the cost of such work.

Sec. 3. Whenever any swamp, marsh or other land has been drained to the approval of said director, he shall keep the same in repair and free from obstruction, and construct or repair tide gates or otherwise treat such areas so as to make such work effective. The cost of such maintenance or treatment, not exceeding in any year one dollar per acre, shall be paid by the state, and the city, borough or town within which such place or area is located shall reimburse the state for three-fourths of the amount so expended for maintenance and treatment of such place or area. The provisions of this section shall apply to work executed prior to the passage of this act, provided such work shall be approved

by the director. Said director shall certify to the comptroller the amount due from any city, borough or town under the provisions of this section, and the treasurer of such city, borough or town, as the case may be, shall pay to said comptroller the amount so due upon receipt of a bill therefor. All amounts so collected shall be available for expenditures under the provisions of this section.

Sec. 4. Said director may appoint one or more deputies to supervise the work done under the provisions of this act, who may exercise the authority granted to such director, and the expenses of said director and said deputies for supervision and inspection shall be included in computing the cost of any such work.

Sec. 5. The sum of five thousand dollars is appropriated for the purpose of carrying out the provisions of sections one and two of this act, and five thousand dollars for carrying out the provisions of section three of this act. The comptroller may advance to said director such amounts, within such appropriations as are necessary to meet the current expenses for the labor authorized under the provisions of this act.

Sec. 6. This act shall take effect from its passage.

Approved May 16, 1917.

As section 4 of Chapter 264, Public Acts of 1915, was not repealed it still remains in force and is as follows:

Any person obstructing the work of examining, surveying, or ditching, or otherwise treating such mosquito breeding areas, or obstructing any ditch, canal, or drain, or the natural outlet of any marsh forming mosquito breeding areas, shall be fined not more than one hundred dollars, or imprisoned not more than ninety days, or both.

The new law provides for a more adequate method of notifying property owners regarding the ditching of their marshes, and provides for assessing benefits and damages in case the owners wish to apply to the courts. At the same time the law specifies that the work shall not be delayed while adjustments are being made. The measure carries an appropriation of $5,000.00 to pay for one-fourth of the cost of new work done under this law.

The maintenance of the work is placed under the Director of the Experiment Station instead of under the towns, as provided in the 1915 law, an appropriation of $5,000.00 being made to pay for one-fourth of the maintenance, which is not to exceed one dollar per acre during one year. Work done before the passage of the Act may be maintained as above after such work has been approved by the Director.

On June 1 the writer was appointed by the Director, Deputy in charge of mosquito elimination work.

New Haven Work.

The City of New Haven appropriated $10,000 for mosquito elimination work during 1917, which was to be expended under Chapter 264 of the Public Acts. The Anti-Mosquito Committee, Inc., of the New Haven Civic Federation, which had raised the funds and had charge of practically all the mosquito work done around New Haven, recommended that this money be used to ditch the remaining undrained salt marsh areas in the town of New Haven. These marshes were as follows: The Fort Hale or Harbor Marsh north of Fort Hale Road, about 120 acres; all of the Quinnipiac Marsh in the town limits, containing about 300 acres; and the West River Marsh between Congress Avenue and Chapel Street, 130 acres, making a total of 550 acres. This recommendation met the approval of Dr. Jenkins and plans were made to go ahead with the work.

The notice or order regarding the proposed mosquito work was published in the *Journal-Courier* on May 25, and under the law it was necessary to wait thirty days before starting the ditching. Two of the leading mosquito drainage firms were asked to bid on the work, and the contract was awarded to the United States Drainage & Irrigation Company of New York, the firm that did the ditching work around New Haven in 1912. The contract was let on a footage basis at a price of 2 5–8 cents per linear foot for 10" x 24" ditches. The Harbor Marsh and the Quinnipiac Marsh, like many other marshes in the State, contained many old ditches which we considered advisable to use in the new system in order not to cut up the marshes unnecessarily. Furthermore, many of these ditches form boundary lines between property owners, and in our previous work serious objections have been made where these boundary ditches have been disregarded, or where new ditches have been cut a few feet from the old ones. As the majority of these old ditches have to be cleaned by day laborers, it was specified in both bids that the cost of cleaning old ditches be figured as the equivalent of a double 10" x 24" ditch.

Harbor Marsh. The Harbor Marsh was the first one to be ditched. Work was started on June 27 and completed on July 5. The equivalent of 44,443 feet of ditch was cut. For a number of years there has been considerable mosquito breeding on the lower end of this marsh near Fort Hale Road, where the only outlet was a ditch to the south, emptying into the moat surround-

ing the old fort, where the water was so high that there has been very little drainage through this ditch. Formerly this portion of the marsh was drained by a ditch, long filled up, with an outlet into the harbor about 1,400 feet to the north. This ditch was re-opened, and while it lowered the water so that there was very little breeding during the remainder of the season, it does not carry off the water as well as expected.

Quinnipiac Marsh. The Quinnipiac Marsh was ditched between July 5 and July 28, a total of 167,988 feet of ditches being dug. The New York, New Haven & Hartford Railroad is filling a section of this marsh south of the Air Line tracks next to the Quinnipiac River. When the filling is completed it will cut off the drainage into the Quinnipiac River of a considerable section of the marsh to the east, and the new ditching has been planned to carry the water eastward into the large creek. It will be necessary to watch this system for another season in order to determine if it is adequate to prevent mosquito breeding. Plate XXVIII shows the appearance of a section of this marsh both before and after ditching.

West River Marsh. The ditching on the West River Marsh was started on July 20, and completed on August 27. 38,355 feet of ditches were cut. The conditions on this marsh are controlled by the large tide gates at the Congress Avenue bridge. These gates have leaked badly for several years and considerable of the time the water in the river has been high, flooding sections of the marsh. During the summer the city repaired these gates, but it is the writer's opinion that a great deal of water leaks through under the sill and that this defect was not remedied. Whether these gates can be kept in satisfactory repair, or whether it would be cheaper in the long run to build new gates is a problem that should be decided by an engineer who is familiar with the construction and operations of tide gates. It is also my opinion that the river needs dredging near the Derby Avenue bridge, and possibly at other points, before the water can be lowered sufficiently above Derby Avenue. Under the present conditions we cannot expect to obtain the best results from the ditching. Much of the surface water of the marsh, however, will be concentrated in the ditches, and the larger pools and lagoons have been connected by ditches with the river, which will prevent the water from becoming stagnant.

Aside from the problems mentioned in connection with the different marshes, the work has been satisfactory and many serious breeding areas have been eliminated. Had it been possible to complete the work in the spring, this season's results would have been much more apparent. During the early part of July when the ditching work was only well started, conditions were extremely favorable for mosquito breeding. The perigee tide was followed by east winds and frequent rains, which kept the depressions in the marshes filled with water, producing one of the largest broods of salt marsh mosquitoes known at this season of the year. Fresh water breeding was equally plentiful.

East Haven Work.

The Cosey Beach Improvement Association raised sufficient money to drain the small but serious mosquito-breeding marsh back of the Silver Sands summer colony and just west of the Momauguin shore resort. The outlet ditch of this marsh crossed the highway to the south and extended to the west for several hundred feet through a number of back yards where the property owners had covered the ditch or partially filled it, as they saw fit. It then again crossed the road to the north and extended to the west into Caroline Creek. The town authorities gave permission to cut an outlet north of the highway and on the town's right of way. This new outlet was 30 x 20 inches and about 700 feet long, and extended through a point of hard land where a number of rocks had to be blasted. While the cost was greater than that of ditching the marsh, it probably cost no more than it would to build two new culverts and clean the old ditch, and the new ditch is much more direct and will be considerably cheaper to maintain.

Additional ditches were cut in the marsh partially ditched in 1912, on the east side of Caroline Creek and connecting with this new work. The above work has done away with practically all of the salt marsh mosquito breeding from Caroline Creek to Mansfield Grove. As all of the money raised by this Association was not expended, the remainder will probably be used in the spring on the marshes back of Mansfield Grove.

Orange Work.

The contract which was let in December 1916, for ditching the lower part of Old Field Creek Marsh in West Haven, was carried

out this spring, the work being completed before the end of May. The town authorities co-operated with the members of the West Haven Anti-Mosquito Committee, who raised the money for the above work, built a new tide gate at the outlet of Old Field Creek, and cleaned the channel of the creek north of Blohm Street through the town property where the sewage disposal plant is located. Dr. Charles D. Phelps, a member of the Committee, has given all this work his personal attention. Plate XXIX shows a portion of this marsh before and after ditching.

Hamden.

The town, as in 1916, appropriated $300.00 to be used in anti-mosquito work during 1917 by the Health Officer, Dr. George H. Joslin. Efforts will be made to have this appropriation increased for 1918 in order to drain a serious malarial breeding swamp between Schuetzen Park and the railroad, just north of the New Haven town line.

Branford, Guilford and Madison Work.

The mosquito drainage work in Branford, Guilford and Madison during 1916 was done under Chapter 264 of the Public Acts, which provided that the maintenance be done by the towns. Early in April the selectmen of these towns were notified of this fact and advised of the importance of starting this work at once. In Madison the ditches were all cleaned under the direction of the first selectman before the middle of May. The work was gone over in Guilford and the principal obstructions in the ditches removed, while in Branford no work was done by the town.

After the present law was passed placing the maintenance under the Director of the Agricultural Station, the work was started as soon as possible. Plans were made to divide the territory into about three districts and engage a man to take charge and be responsible for the results in each district, hiring laborers for doing such work as was not practicable for him to do.

Mr. Joseph S. Miller, a student of the Connecticut Agricultural College, who was specializing in entomology, was engaged to take charge of one district. The season was so far advanced that most of the men who are usually available for summer work had already secured employment or entered training camps, and we

were unable at short notice to obtain suitable men for the remaining districts. As no work had been done in Branford, Mr. Miller started cleaning the ditches in this town and later took charge of the maintenance work in the other two towns.

BRANFORD.

After considerable difficulty, owing to the labor situation, two laborers were engaged and work was started June 4 on the Hotchkiss Grove Marsh. During the winter the tide gates at the outlet became damaged so that the marsh was flooded with water and many of the ditches partially filled with mud. Nearly full-grown larvae of *Aedes cantator* and *A. sollicitans* were present in many pools and even in some of the obstructed ditches, especially in the upper section of the marsh. These breeding places readily drained away when the ditches were cleaned, but as there was not sufficient time to go over the whole area before the adults emerged, a number of the breeding places were oiled.

The ditches in the remainder of the marshes in the town required only a small amount of cleaning aside from the removal of sod placed in the ditches by the farmer to bridge them, and occasional stoppage casued by material which had been carried in by high tides.

GUILFORD.

After the work was well started in Branford, the marshes in Guilford were inspected and it was found that while the principal obstructions had been removed by the town, very little had been done to remove the mud which had accumulated in many of the old ditches. Work was commenced as soon as laborers could be hired, and those employed in Branford were later moved to Guilford.

The small tide gate at the Leete Marsh was found to be leaking badly around the box where the water had worked through. A member of the Connecticut Shore Mosquito Extermination Association, who had a summer residence in the vicinity, offered to pay the cost of having a concrete facing, on which to hang the gate, built on the outer side of the box. This improvement was made and the water in the ditches was lowered sufficiently to thoroughly drain the marsh.

The need of a new tide gate at the outlet of the Great Harbor Marsh has been apparent during the past two seasons. Authority for building tide gates is granted in the new law under Maintenance (Sec. 3) so that the cost of construction, together with the cost of maintenance, is limited to one dollar per acre. Plans were made for a new gate to be attached to the trestle of the Shore Line Trolley which crosses the Great Harbor Creek near its outlet. By the time estimates on the cost of building could be obtained and permission received from the trolley officials to attach the gate to their structure, it seemed advisable to wait until spring before installing the gate.

Before all the Guilford marshes could be covered, the July perigee tide occurred, which was abnormally high, due to strong east winds. This was followed by frequent rains and produced scattered breeding over the marshes. Many complaints were received regarding the abundance of mosquitoes in Guilford borough which did not seem to be explained by the amount of marsh breeding. Mr. Miller investigated the matter and reported that nearly every rain barrel and receptacle containing water that he examined were breeding mosquitoes. Many unused boats with water in them also contained wrigglers. One individual, living on one of the main streets, who was complaining to Mr. Miller about the abundance of mosquitoes, was shown prolific breeding in a boat in his back yard.

MADISON.

The box culverts that were placed in the outlets to several of the small marshes in 1916, all remained in place during the winter. While the ditches on the Madison marshes were cleaned in the spring by the town, there are a number of small marshes that are drained through old outlet ditches which require considerable cleaning throughout the season, thus adding materially to the cost of maintenance.

COST OF THE MAINTENANCE WORK.

Labor	$1,193.57
Tools and supplies	29.24
Supervision and Inspection	424.29
	$1,647.10
Cost per acre	.617

The results of the maintenance work in these shore towns was as satisfactory as could be expected under the circumstances. The greater part of the work which should have been done early in the spring, had to be done after the first of June when the breeding season was well under way.

It was not practicable to organize the work and engage men beforehand in anticipation of the passage of the law. Labor was scarce and the majority of the few men looking for work preferred other kinds to that on the salt marsh, even though the pay was less. It was necessary to pay nearly twice as much for laborers as it would have been two years ago.

Fairfield Work.

The salt marshes in the town of Fairfield, about 1,250 acres, were ditched to eliminate mosquito breeding in 1912, the necessary funds being raised by private subscription. The work has since been maintained under the supervision of the Improvement Association of Fairfield. During the last week in June a request was received from the first selectman of the town that the maintenance of this work be taken over by the Director of this Station, under the new law. The work was inspected by the writer and approved on July 11. The maintenance work was being done by Mr. Nicolas Matinck, who had also been employed during 1916. Mr. Matinck continued with the work until September 1.

Proposed Work in Westport.

Early in the spring the State Comptroller requested that the marshes in the town of Westport on or adjoining the State Aviation Park at Alvord's Beach, be examined to determined the mosquito breeding conditions. Westport is the only town between Fairfield and the New York State line where the salt marshes have not been drained to eliminate mosquito breeding. As it will be necessary to ditch all of these marshes in order to obtain any definite results, all of the salt marshes in the town were examined on April 16. The report sent to the Comptroller was as follows:

WESTPORT SALT MARSHES.

Examined April 16, 1917, by B. H. Walden.

There are about 330 acres of salt marsh in the town of Westport. The problem of ditching to eliminate mosquito breeding is a simple one. The areas are comparatively small and well supplied with natural water courses or creeks. These marshes, like most of those in the state, were formerly ditched for salt hay farming, and while salt hay is still cut on considerable of the area, the ditches have been neglected and most of them nearly filled up. While the whole area needs ditching, with a few exceptions, it probably will not be necessary to cut ditches nearer than 150-175 feet apart.

Detailed accounts of the separate areas follow: 1 & 2. Marsh southwest corner of town west of the Saugatuck River. Area about 74 acres. Adjoining marsh in Norwalk ditched in 1912. This area requires the longest ditches of any marsh in the town (about 1,000 feet). It may therefore be necessary to place them not over 125-150 feet apart.

Salt hay was cut on a large portion of this marsh in 1916 and the western part of it was fairly hard and dry on April 16.

3. About 5½ acres. Appears to be well drained. Hay cut in 1916. May require a few short ditches.

4. Marsh west of station south of railroad tracks. Thirteen acres. Good natural drainage. Probably needs marginal ditches. West of the highway is a small marsh of less than one acre, the outlet leading through a culvert under the road into a creek of No. 4. This marsh is in a very bad condition and needs thorough ditching. Probably considerable fresh water comes onto this marsh and the indications are that it is a malarial mosquito breeder.

5. This is the upper end of the marsh No. 4 above the railroad tracks. The main ditch needs cleaning the whole length. Sink drains on the western bank run into this marsh producing an unsanitary condition; tile drains should be laid to the main ditch.

6. Small narrow marsh west of main road east of Cedar Point. About ½ acre of the lower end of this marsh needs ditching.

7. West side of Mill Cove. Area 20 acres. Upper portion needs ditching. Hay cut on most of this marsh.

8. Triangular marsh south of railroad extending into Mill Cove. Needs two or three cross ditches. Area 11 acres.

9. Marsh on east side of Mill Cove. Area about 46 acres. East side of creek hay has been cut. Needs ditching, especially west of creek.

10. Marsh adjoining State Aviation Park—about 128 acres. On the west side of marsh part of the hay has been cut. Needs ditching. In the central portion of marsh about 20 acres probably well drained by natural creeks. Southwest corner either on or adjoining State property especially needs ditching.

The west half of the marsh south of the creek and owned by the State probably requires no ditching. The east half of the marsh owned by the State should be drained with ditches about 175 feet apart.

The outlet of the creek that drains this marsh (the northern boundary of the State property) is through the beach where it is in danger of filling up. While the outlet is adequate for good drainage, at the present it will require opening occasionally. The northern part of the marsh needs ditching.

11. Marsh south of Greens Farms railroad station. About 17 acres. This marsh is in fair shape but will require ditching.

12. Marsh near east boundary of Westport southwest of the mouth of Sasco Creek. Area 10 acres. Old ditches need cleaning and an occasional new ditch.

13. Marsh west side Sasco Creek. Area 20 acres. The area between the railroad and the highway on the south has been ditched. The area north of the railroad probably has been ditched but was not examined.

During the past season Mr. W. L. Searles of Rowayton, who was mainly responsible for carrying out the ditching in the towns of Norwalk and Darien, spent considerable time in interesting the people of Westport to raise funds for ditching these marshes. On August 21, the writer met Mr. Searles and visited some of the people interested in the work. More than one-half of the necessary funds were pledged and it is hoped that sufficient money will be available to carry out the work in the spring.

ENTOMOLOGICAL FEATURES OF 1917.

The winter was rather mild and the temperature did not go sufficiently low to kill the peach buds—or at least a large proportion were not killed. Spring came late, however, and the blossoming of fruit trees and other events in plant development were fully two weeks—and in some instances three weeks—behind the average season. Spring and early summer, therefore, were cold and wet. Seeds requiring a high temperature could not safely be planted until late in May or even in June. Rainfall was heavy until August 1st, and the remainder of the season it was light—somewhat below the normal. On account of stormy weather while fruit trees were in bloom, bees could not work the blossoms, consequently there was a poor set of apples in many orchards on account of lack of pollination. The young apples fell off from each fruit cluster by the handful, because the flowers had not been fertilized. There was much damage from rosy aphis, *Aphis sorbi* Kalt, and from the false red bug, *Lygidea mendax* Reut.

Though there were many egg-clusters of the tent-caterpillar, *Malacosoma americana* Fabr., there were few nests, and comparatively few caterpillars developed and produced adults. Consequently the egg-clusters will not be found abundantly on the trees this winter.

Canker worms did only a moderate amount of damage.

The first rose chafer observed was on June 18, and a few days later the beetles came in their usual numbers. The earliest date heretofore recorded for New Haven is June 9, and the beetles usually appear in abundance on June 12.

In truck gardens the cabbage root maggot caused the usual amount of damage.

Cut worms were not especially troublesome. The striped cucumber beetle, *Diabrotica vittata* Fabr., was very abundant and troublesome at the Station farm at Mt. Carmel, and squash bugs caused the usual amount of injury.

Wireworms were reported as seriously injuring tobacco in a number of fields, and later in the summer attacked potato tubers in the ground.

The wheat midge, *Contarinia tritici* Kirby, injured a field of rye in Yalesville, and caused slight damage to a field of winter wheat in Westport.

Perhaps the most prominent entomological feature of the season was the outbreak of the pink and green aphid, *Macrosiphum solanifolii* Ashmead, in potato fields all over the State. This pest appeared in July, and in most cases the plants were seriously infested before the insect was known to be present. Spraying with nicotine solution was practiced but the injury had already been done and the yield was greatly reduced, thus causing a loss of thousands of dollars for the whole state. There were fields here and there which were not attacked, but the pest was reported from every county in Connecticut, and the infestation was rather general. It was especially prevalent in New Haven County.

The elm leaf beetle was observed at several points, and seemed to be more prevalent, particularly along the shore, than for several years.

Tussock moths were unusually abundant. The white-marked tussock moth, *Hemerocampa leucostigma* S. & A., was perhaps even more abundant than in 1916. The white egg-clusters were in evidence on the trunks and branches of trees in the cities and

towns and the caterpillars injured the foliage. The hickory tussock moth, *Halisidota caryae* Harr., was more prevalent than since 1907. The tessellated tussock moth, *H. tessellaris* S. & A., was more abundant than I have ever seen it around New Haven, and late in the summer the caterpillars were crawling everywhere in company with those of the other two species just mentioned.

The fall webworm, *Hyphantria cunea* Dru., was also prevalent and its nests were seen on fruit, shade and woodland trees throughout the State.

In young orchards and nurseries, the red-humped caterpillar, *Schizura concinna* S. & A., and the yellow-necked caterpillar, *Datana ministra* Dru., were unusually abundant and could be seen feeding in clusters, often stripping the trees. The walnut caterpillar, *Datana integerrima* G. & R., was more prevalent than for several years and completely defoliated many black walnut, butternut and hickory trees in August.

Adults of the eight-spotted forester, *Alypia octomaculata* Fabr., were common in June, but there was no such stripping by the caterpillars observed or reported as took place in New Haven in 1916.

Grasshoppers and crickets were very abundant during August and September and devoured much of the second crop of hay in many fields.

The turnip aphid, *Aphis pseudobrassicae* Davis, appeared in a few turnip fields but caused no such destruction to turnips and kale as was the case in 1916.

The imported cabbage worm, *Pontia rapae* Linn., and the cabbage looper, *Autographa brassicae* Riley, were prevalent in all cabbage fields in late summer and riddled the leaves.

The apple maggot, *Rhagoletis pomonella* Walsh, continues to do its usual amount of damage.

The Bureau of Entomology of the U. S. Department of Agriculture at Washington has, during the year, established in Connecticut at Wallingford a field station for the study of deciduous fruit insects, to be conducted in co-operation with this Station. Mr. E. H. Siegler is in charge of this field station and it is planned to start work of an investigative nature on the tent-caterpillar, apple maggot, peach borer, and possibly certain other fruit insects which need to be studied under Connecticut conditions. It is hoped that the orchardists of the State may receive much benefit from these investigations.

The brown-tail moth has through the year been very scarce throughout the area supposed to be infested, and has not extended its range the usual distance westward. The towns were not required to spend any money in destroying nests as in 1916.

There was a marked increase in the number of infestations of the gipsy moth, apparently due to wind-spread in the spring of 1916, though this was not discovered until scouting was done the following winter. This increase was especially noticeable in the towns of Thompson, Putnam, Woodstock and Killingly, but also showed in Pomfret, Eastford, Brooklyn, Hampton and Canterbury.

A new peach pest, *Laspeyresia molesta* Busck, has appeared in Stamford and New Canaan. This insect is a small moth and the larva is a borer in the terminal twigs of peach trees in orchards. So far this insect has not been found in the nurseries of Connecticut.

The army worm, *Cirphis* (*Heliophila*) *unipuncta* Haw., was reported from Northford and Orange, but only a few caterpillars were seen and did no damage.

A leaf-roller, *Olethreutes hemidesma* Zell., was common on *Spiraea Van Houtei* in some parts of the State.

As regards anti-mosquito work, considerable progress was made during the year. The legislature amended the law, greatly improving it and providing for both new work and maintenance to be done by the State, and making a small appropriation for the purpose. Three-fourths of the cost of the maintenance is collected from the towns by the State Comptroller. The first part of the season was rainy, forming pools, and was favorable for breeding mosquitoes. Considerable new ditching work was done in New Haven, East Haven and Orange, and maintenance work in Branford, Guilford, Madison, New Haven and Fairfield was supervised by the State.

More detailed accounts of the principal features of this chapter will be found in the pages of this report.

MISCELLANEOUS INSECT NOTES.

A Sawfly Borer in Poplar. On September 25, 1916, Mr. Zappe collected some borers in small twigs of Lombardy poplar near Derby. On June 1, 1917, an adult emerged, which we recognized as *Janus abbreviatus* Say, a species not before recorded from Connecticut.

Sawfly Larvae on Austrian Pine. On August 2, 1916, Mr. Zappe collected some sawfly larvae on Austrian pine in a nursery in New Haven. The larvae live in silken tubes or webs, and spend the winter in cells in the ground. On June 7, 1917, adults emerged which have been identified by Mr. Rohwer as an undescribed species of *Itycorsia.*

Army Worm. The army worm, *Cirphis* (*Heliophila*) *unipuncta* Haw., which was prevalent in the State in 1914 (See Report of this Station for 1914, page 157), was reported from two places in 1917. Caterpillars were brought in from Northford and were observed in Orange. They were not abundant, only a few being noticed, and did no appreciable damage.

Long-Horned Beetle a Borer in White Pine. On September 22, 1916, Mr. Zappe collected some borers in white pine on the grounds of Mr. C. H. Sierman in Hartford. These borers were in the main stem in about the same place that one would expect to find the white pine weevil, though perhaps a trifle lower, and some of them tunneled into the center of the stem. These were placed in a breeding cage, and on June 10, 12 and 26 adults emerged. They proved to be *Monohammus titillator* Fabr.

Leaf Roller on Virginia Creeper. In 1916 the writer noticed several rolled leaves on a Virginia creeper on his front porch, and on August 27 collected a few specimens for the insectary. On June 18, 1917, there emerged a small black moth marked with white spots and known to entomologists as *Desmia funeralis* Hübn., of the family Pyralidae. This insect also feeds upon grape.

A Sawfly on Balsam Fir. On July 24, 1917, we received some sawfly cocoons, collected in Danielson by Mr. Davis on Balsam fir. The pupae were rather abundant, and much resembled those of *Diprion simile.* On August 6, adults began to emerge. Mr. S. A. Rohwer has identified the species as *Diprion abietis* Harr., which has been previously recorded from Connecticut.

Twig Borers in Sourwood, Dogwood and Azalea. While inspecting nurseries in August and September, 1916, Mr. Zappe found several twigs containing borers. At one nursery in New Haven a branch of the sorrel tree or sourwood, *Oxydendrum arboreum* was infested; at another he found an azalea stem tunneled; at a Hartford nursery a red-twig dogwood was attacked. As these twigs all contained the larvae, they were placed in separate cages in the insectary. During the last of May the adults emerged.

That from the dogwood was *Oberea tripunctata* Swed. Those from Azalea and *Oxydendrum* proved to be *O. tripunctata* var. *myops* Hald.

The Sinuate Pear Borer in Connecticut. On May 29, 1917, a piece of bark from a pear tree was received from Mr. G. S. Brown of Norwalk. Mr. Brown wrote that a worm had eaten under the bark all around the trees and the branches. Several trees were attacked. The work of the insect was probably that of the sinuate pear borer, *Agrilus sinuatus* Oliv., which has damaged pear trees in New Jersey for at least twenty years, but which has not before been reported from Connecticut. No good remedy has been found other than destroying the infested trees.

Harrisina americana on Virginia Creeper. On August 27, 1916, the writer gathered from a Virginia creeper vine a colony of small larvae feeding upon a leaf. The dorsal surface was striped crosswise with black and yellow bands, and there was a black line on the side of the body. Under surface was white. Adults emerging June 12, 1917, were *Harrisina americana* Harr., a small moth with narrow, smoky wings, belonging to the family Pyromorphidae. The food plants are grape and Virginia creeper.

A Pest of Wheat Middlings. On October 10,1917, specimens were received from Mr. A. D. Jacot, R. F. D. Sandy Hook, of wheat middlings infested with some form of insect life. The sample was examined and the insects were found to be winged psocids (family Psocidae) and were identified by Mr. Nathan Banks as *Pterodela pedicularis* Linn., a species with a previous record of doing damage in various stored plant and animal products. Heat would be a satisfactory remedy.

Weevil in Evening Primrose. The evening primrose (*Œnothera biennis*), commonly regarded as a weed in waste fields, is a common inhabitant of orchards, growing around the borders, or in that portion between the cultivated strips, if clean cultivation is not practiced. In nurseries the plant is common and in one nursery at New Canaan nearly every plant was infested with grubs tunneling in the stem, the tunnels being shown on plate XXXI, b. Adults were reared October 23, and were identified as *Tyloderma foveolatum* Say, one of the weevils or snout beetles.

A Leaf Beetle on Peas. On July 20, 1917, larvae were brought to the Station which had been found feeding upon peas and wild morning glory at Triangle Farm, Wallingford. These somewhat

resembled the larvae of the squash lady-beetle, but were without spines. On July 30, adults were reared, and proved to be *Chelymorpha argus* Licht., a leaf beetle of the family Chrysomelidae. This beetle commonly feeds upon the wild morning glory (*Convolvulus*), and sometimes attacks milkweed (Asclepias) and raspberry, but I do not recall having seen it recorded as attacking peas.

The Cynthia Moth at Stonington. On September 10, 1917, a caterpillar of the Cynthia moth, *Philosamia cynthia* Drury, was received from Mr. Oscar Swallow of Stonington. This caterpillar pupated September 15. Mr. Swallow gave Mr. Zappe some cocoons collected November 11, 1917. The caterpillars feed upon the leaves of Ailanthus or Tree of Heaven. They are large, fleshy, green caterpillars bearing soft bluish protuberances. The adult has a wing-spread of four or five inches, ground color olive drab, with wings crossed by pink and white bands, and each wing bearing a transparent eye spot edged with yellow. The species is an importation from China, and has become fairly common in the vicinity of New York City. It has previously been reported from Greenwich, Conn.

Elm Leaf Beetle More Abundant. For several years the elm leaf beetle has been on the decrease in Connecticut so that in most towns along the coast spraying the elm trees has not been practiced and little injury has been done to the trees. In 1917, however, increased activities of this insect were noticed at several points. There were many riddled leaves in Fairfield and vicinity, and at Greenfield Hill many trees were entirely defoliated. Its ravages, though less marked, were noticed at Manchester and Saybrook. These observations indicate that the elm leaf beetle may again appear in devastating numbers, and the residents of each town should be on the watch, ready to spray before the trees are injured. One thorough application of lead arsenate (3 lbs. of the paste in 50 gal. of water) about June 1st will generally protect the foliage for the season.

Eggs of the European Lackey Moth or Tent-Caterpillar Intercepted on Nursery Stock from Holland. On November 16, 1916, while inspecting some imported nursery stock at the greenhouses of the M. A. Free Co., Stamford, Mr. Zappe found an egg-cluster of the European lackey moth or tent-caterpillar, *Malacosoma neustria* Linn., which had been brought over in the shipment from Boskoop, Holland. There were several kinds of plants in the

shipment, including a species of *Malus*, upon which the caterpillars are known to feed. This insect makes nests on the trees and the caterpillars feed upon the leaves of fruit and other deciduous trees in much the same manner as the tent-caterpillar and the forest tent-caterpillar in this country. Had this egg-mass not been intercepted, a colony might have started, from which this additional pest might have become established in this country.

Disappearance of Tent-Caterpillar. The tent-caterpillar, *Malacosoma americana* Fabr., which has been exceedingly abundant during the past four years, has almost entirely disappeared in Connecticut. Egg-clusters were fairly common and it was expected that nests would be seen here and there on apple and wild cherry as usual, though perhaps in fewer numbers. In many cases the eggs hatched and the young caterpillars began their nests. The nest building did not develop far, however, and very few caterpillars ever developed into pupae or adults. Consequently this insect will not be a pest to reckon with in 1918. The writer was informed of one locality in Windham County where the caterpillars hatched and the nests developed normally. Here many mature caterpillars were seen and possibly egg-clusters may now be there upon the twigs of the trees. But in most sections of the State this insect was scarce in 1917 and will probably be even more so in 1918. The reason for its disappearance cannot be explained here, but is probably the effect of parasites or other natural enemies. The tent-caterpillar fluctuates in abundance, and periodically about every ten or twelve years is extremely abundant. This period of abundance usually lasts two or three seasons but in the period just passed, it has been abundant for four, and in some sections for five years.

A Bark Miner of Apple Twigs. Several times during the past fifteen years correspondents have sent to the Station specimens of apple twigs with serpentine mines just under the epidermal layer and light brown in color, being rather conspicuous on the twigs. The writer has often observed and collected material of these mines and once obtained a flattened larva, which was mounted in balsam. All efforts to rear the adult failed though many trials were made. Recently, however, the life history of this insect has been worked out by Mr. Stuart C. Vinal, who has published

the result of his studies.* It proves to be the larva of a small moth, *Marmara* (*Gracilaria*) *elotella* Busck, originally described in 1909.† Several times each year twigs are received which contain these mines. Thus, on November 24, 1916, some were sent from Norwalk; January 2, 1917, Cos Cob; February 13, Norwichtown; February 20, Cheshire; March 5, South Norwalk; March 30, Norwich. The larva and the mined twigs are shown on plate XXX, b and c. Apparently little or no injury results from these mines as the cambium is not reached. Hence control measures are scarcely needed.

A Leaf-Roller on Spiraea: Olethreutes hemidesma Zell. When inspecting nursery stock in the town of Ellington, August 14, it was noticed that many of the terminal shoots of *Spiraea van houtei* had their leaves drawn and fastened together by silk threads. Inside some of these nests a larva was found; others were empty. These nests were more plentiful in Ellington than in any other nurseries in the State, though noticed in Manchester. They are shown on plate XXXI, a.

A number of the nests were gathered, brought to the Station and placed in cages in the insectary. On August 24 several adults had emerged, and were recognized as *Olethreutes hemidesma* Zell., a moth of the family Tortricidae. This moth has a wing-expanse of about five-eighths of an inch, is chocolate brown in color, with the basal portion of the wings more or less mottled and marked with narrow, white, sinuous transverse lines. It is shown on plate XXXI, b.

This insect will probably not become sufficiently abundant to seriously injure or disfigure the shrubs, but in case it does, spraying with lead arsenate may be practiced. The poison should be applied during July. Clipping off and burning the infested shoots will also help to control the insect and may be the only control measure necessary if one has only a few shrubs in danger of attack.

Abundance of Grasshoppers. During the summer of 1917 grasshoppers and crickets were unusually abundant, and did considerable damage by eating the second crop of grass in many fields. At the Station farm at Mt. Carmel, in the orchards where spraying experiments were conducted, around the nurseries which we inspected, and in other places visited in various parts

* Jour. Econ. Ent. Vol. 10, page 488, 1917.

† Proc. Ent. Soc. Wash. Vol. xi. page 102, 1909.

of the State, the conditions were similar. Both immature and mature grasshoppers were present and in many cases the results of their feeding were noticeable. There is some danger that they may do damage in these fields next year. Probably the best method of control is the poisoned bran mash, such as is recommended for cutworms. It may be prepared as follows:

Wheat Bran	25 lbs.
White Arsenic or Paris Green	1 lb.
Cheap Molasses	2 qts.
Lemons	3
Water	3½ gallons.

Mix the bran and poison together thoroughly while dry. Squeeze the juice of the lemons into the water and also add the pulp and rind cut in small pieces. Add the molasses and stir. Add this liquid slowly to the poisoned bran and mix thoroughly. When finished, this mash is rather dry and easy to spread. To kill grasshoppers it should be sown or scattered about over the infested fields.

An Injurious Weevil Attacking Red Pine. On August 11, 1917, Mr. A. E. Moss, Assistant Forester, sent to the Station from Norfolk a section of the main trunk of a red or Norway pine about four inches in diameter which had been weeviled, even below the surface of the ground, and killed. The cells contained larvae and pupae which seemed somewhat larger than those of the white pine weevil, which kills the leaders of white pine trees throughout the Northeastern States. Moreover, the trunk or stem in this case was much larger and had thicker bark than the favorite point of attack of the white pine weevil. The red pine trunk was photographed and placed in breeding cages. On August 20, several adults had emerged, and Mr. Walden identified the species as *Pissodes approximatus* Hopkins, described in Technical Series No. 20, page 49, Bureau of Entomology, U. S. Department of Agriculture. The adult resembles the white pine weevil, but is a trifle larger, with markings more prominent, and wing covers more strongly narrowed posteriorly. It is shown on plate XXXI, c, and its work on plate XXXII.

Such attacks would finally kill the trees. Apparently only an occasional tree is attacked. In the red pine plantations of the

State Experimental Forest at Rainbow no such attack has ever been observed. A few years ago similar injury to a young stone pine was noticed in one of the nurseries, and the tree sent to the Station. All weevils had emerged, however, and nothing enlightening could be learned about it. At present, destroying the infested trees seems to be about the only control measure to be recommended.

Wheat Midge Injuring Rye in Connecticut. In response to a complaint, Mr. Zappe visited the field of Mr. George E. Hough at Yalesville, Town of Wallingford, on June 25, 1917. About half of a rye field containing about four acres produced no kernels in the heads, though plants and heads were otherwise well formed and thrifty. The other half sown two weeks later gave a good yield. This difference was sharply marked and could be detected from a distance, the injured field ripening and the straw turning yellow earlier than the uninfested field. A careful examination of the empty heads revealed the cause of the failure. Small reddish maggots were present in the hull where each kernel should be. These are the larvae of a small, two-winged fly known as the wheat midge, *Contarinia tritici* Kirby, a species first observed in England in 1795, and first noticed in America near Quebec in 1819, and in northern Vermont in 1820. About 1828 this insect had increased to such an extent that the wheat crop was abandoned in many localities in northern New England. Every few years until about 1860, this insect caused severe injury, the most serious being in 1854, when Dr. Asa Fitch, then State Entomologist of New York, estimated the injury to amount to $15,000,000.00 in New York State alone. Serious damage was also done in 1857 and 1858.

There is probably but one brood each year, though some evidence has been produced to show that in certain seasons in some parts of the country there is a partial second brood.

Though wheat is usually the crop damaged, sometimes rye, barley, and oats are injured by this insect. Considerable damage to rye in 1917 was reported from certain portions of New York State.

Specimens of the same insect in winter wheat were received at this office on July 18 from Westport. The infested stalks were much shorter than the normal stalks. The adult is a small, two-winged fly which appears about the middle of June and lays

its eggs in a groove at the summit of the chaff. The eggs hatch in about a week and the maggots burrow into the kernels which are then forming. The maggots are of a reddish color and the insect is sometimes known as the "red weevil." The larvae enter the ground to pupate.

Dr. Felt states that there are no satisfactory control measures, but Sanderson advises burning the stubble, deep fall plowing and a rotation of crops.

Note Regarding Authorship.

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a. Planting a colony of parasities. Groton.

b. Spraying to kill gipsy moth caterpillars.

GIPSY MOTH WORK.

a. Apple leaves injured by the false red bug.
Leaves natural size, bug nearly three times enlarged.

b. Spraying to kill aphis and red bug.
Smith's orchard, Clintonville.

FALSE RED BUG.

a. Half-grown apples showing red bug injury.

b. Mature apples injured by red bugs early in the season.

FALSE RED BUG.

a. Eggs, as laid in the soil. Five times enlarged.

b. Striped cucumber beetle. Enlarged four times.

c. View at farm showing protectors over cucumber plants

STRIPED CUCUMBER BEETLE.

Cucumber plants injured by the larvae of the striped beetle.
Natural size.

1. Adults, female and male, twice natural size; 2. Eggs in pine needle, about four times enlarged; 3. Cocoons, natural size; 4. Larvae feeding on pine, natural size.

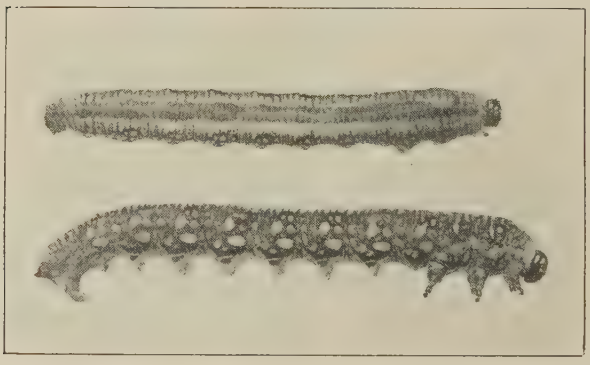
IMPORTED PINE SAWFLY.

Diprion simile: Hartig.

b. *Pinus cembra* about seven feet tall almost defoliated by larvæ.

a. Japanese or Bhotan pine, *Pinus excelsa*, partially stripped by larvæ.

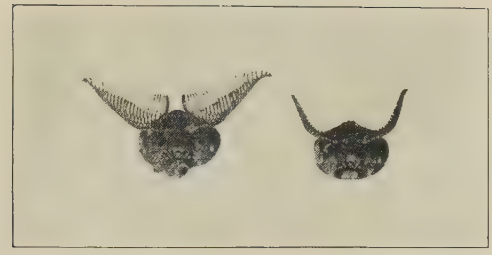
a. A heap containing 1,617 cocoons, collected from pine twigs.



b. Dorsal and lateral view of larva, twice enlarged.

c. Cocoons at left have been torn open, probably by birds; those at right show exit holes of Chalcid parasite. Natural size.

IMPORTED PINE SAWFLY.



a. Male and female antennae. Four times enlarged.

b. Old cocoons with new ones made inside them. Twice natural size.

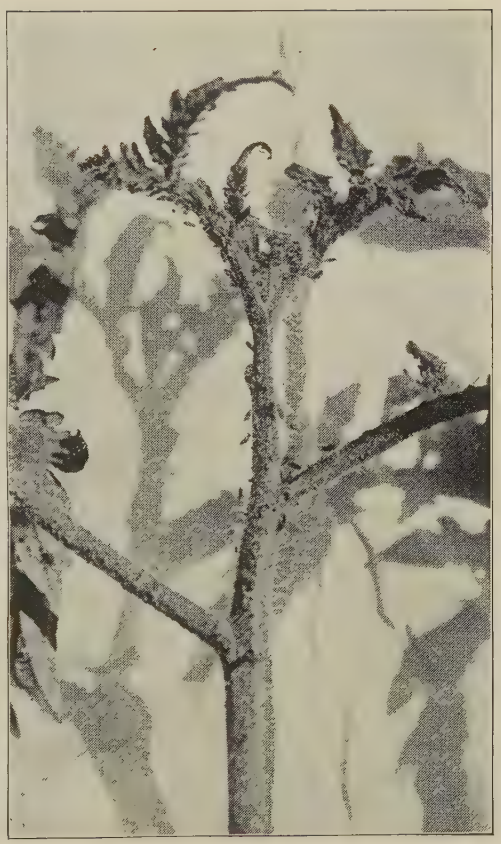
c. Eggs laid in pine needles, four times enlarged.

d. Gynandromorph, left side like female, right like male. Twice enlarged.

e. Tachinid parasites which were unable to escape from cocoons. Twice enlarged.

IMPORTED PINE SAWFLY.

POTATO APHID.



a. Growing tip of tomato badly infested with aphids. (After Houser, Guyton and Lowry, Ohio Agr. Expt. Sta., Bull. 317.)

b. Potato plant injured by aphids.

1 2 3

a. Three important predaceous enemies of the pink and green potato aphid. 1. Larva of lace-wing fly; 2. Lady beetle larva; 3. Larva of Syrphus fly. (After Houser, Guyton and Lowry, Ohio. Agr. Expt. Sta., Bull. 317.)

b. Potatoes killed by pink and green potato aphid, Hamilton County, Ohio (June 30, 1917.) (After Houser, Guyton and Lowry, Ohio Agr. Expt. Sta., Bull. 317.)

POTATO APHID.

a. View in greenhouse, where cockroaches injured plants, Cromwell.

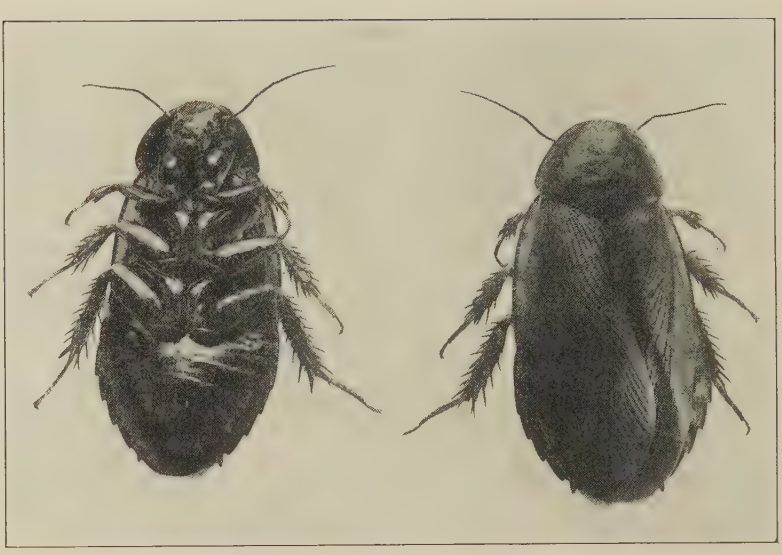
b. Rose plant with bark eaten off by cockroaches. Natural size.

c. Egg-sac of cockroach. Twice enlarged.

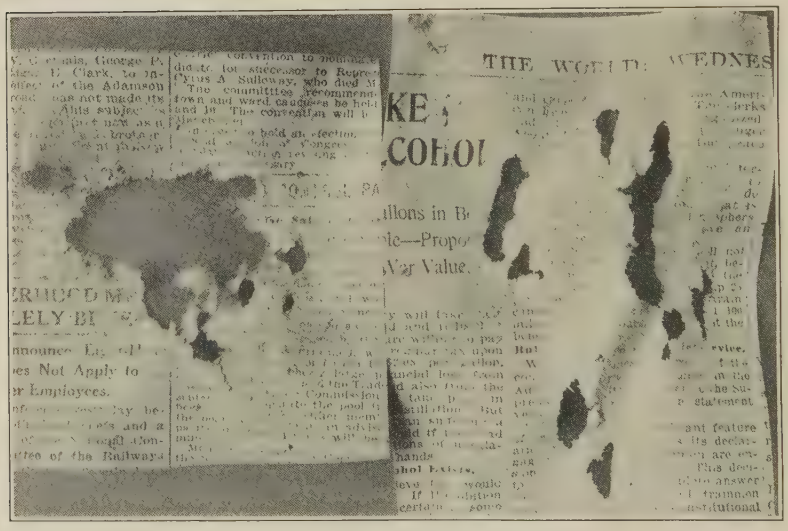
AN EXOTIC COCKROACH.

Easter lilies with bark and roots eaten by cockroaches. Natural size.

AN EXOTIC COCKROACH.



a. Adult female, ventral and dorsal view. Enlarged three times.



b. Holes in newspaper where cockroaches ate the cyanide bait. No dead roaches were found.

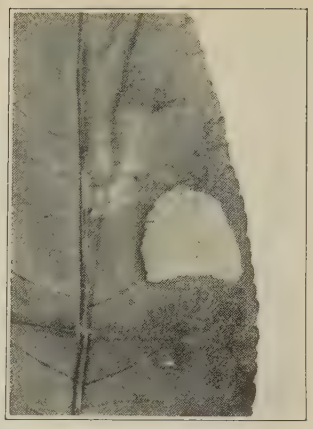
AN EXOTIC COCKROACH.

a. 708 dead cockroaches.

b. View looking downward in one of the walks, showing roaches killed by kerosene spray.

AN EXOTIC COCKROACH.

a. Nests of fall web-worm. (After Slingerland.)



b. Egg-cluster on peach leaf. Natural size.

c. Adult female, natural size.

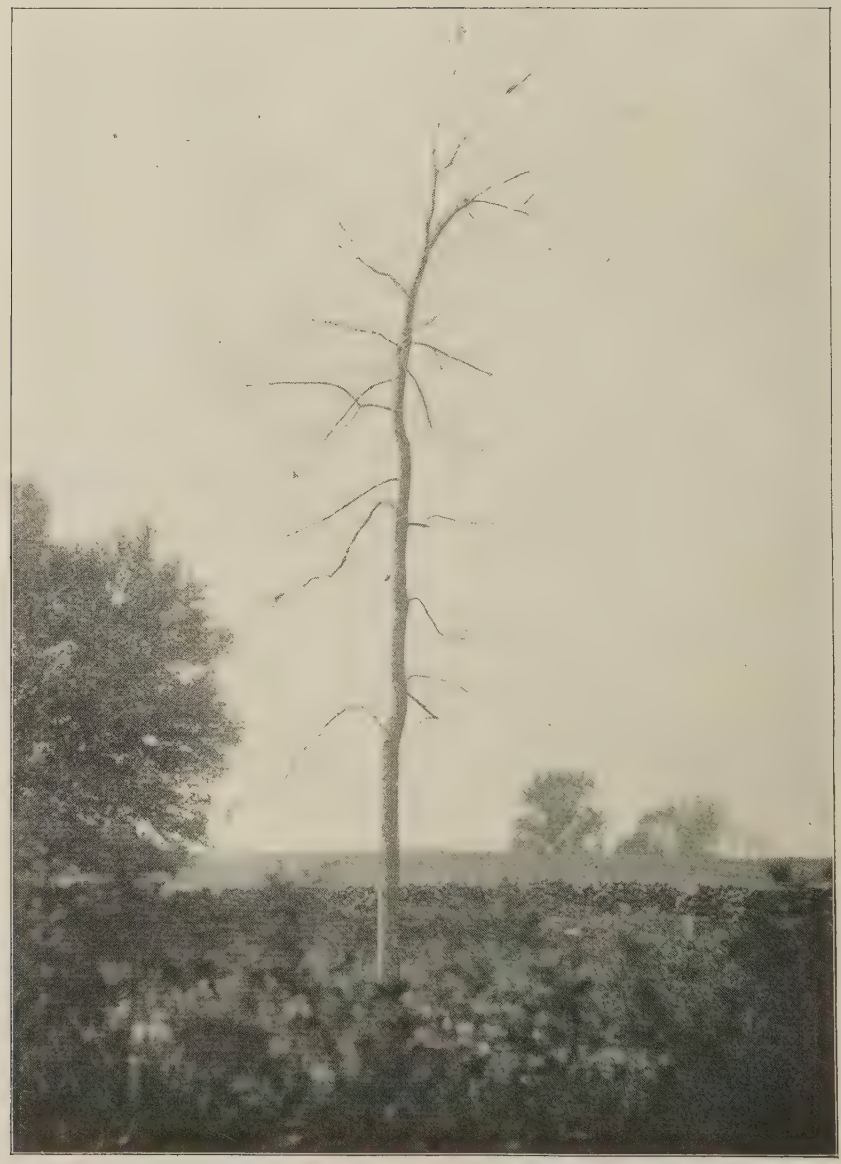
d. Young larvæ feeding on hickory leaf. Natural size.

FALL WEB-WORM.

a. Nest on chestnut.

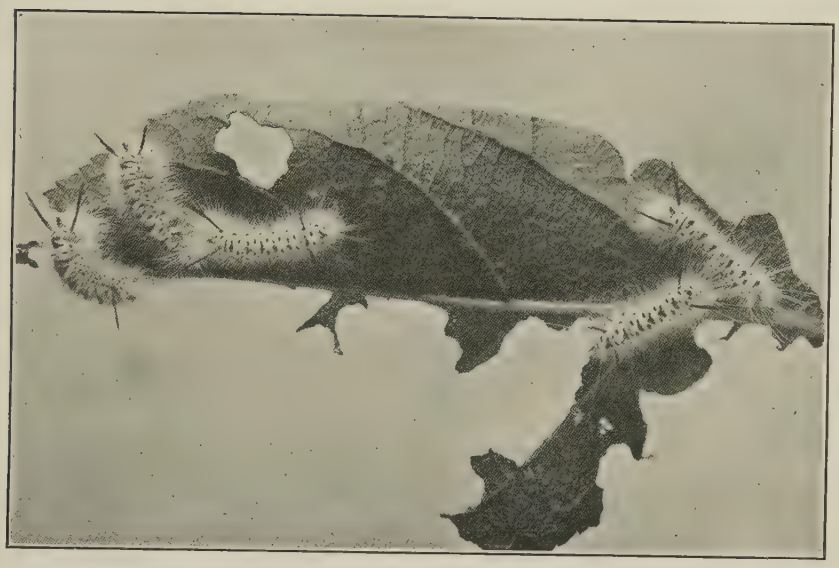
b. Nest on hickory.

FALL WEB-WORM.



Hickory tree defoliated by the fall web-worm. New Canaan.

FALL WEB-WORM.



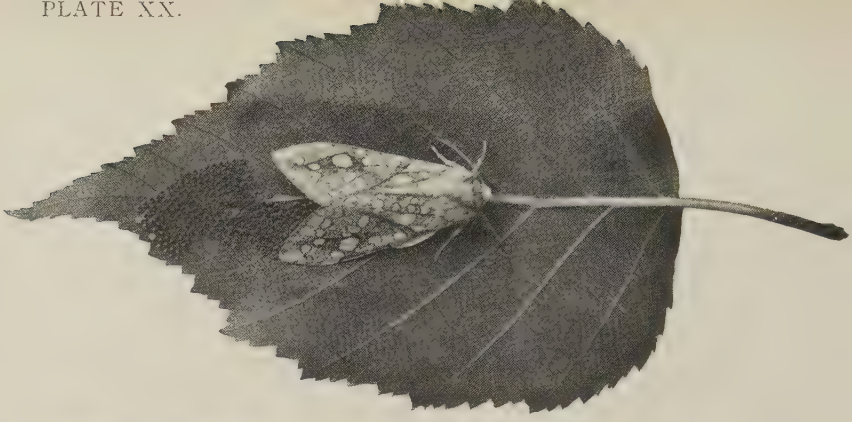
a. Penultimate stage of caterpillars. Natural size.

b. Fully-grown caterpillar on leaf. Natural size.

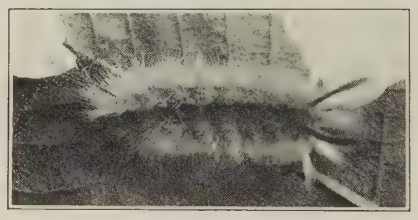
c. Cocoon. Natural size.

d. Adult. Natural size.

HICKORY TUSSOCK MOTH.



a. Female and egg-cluster of hickory tussock moth. Natural size.



b. Larva of tessellated tussock moth. Natural size.

c. Trunk of maple tree showing tussock moth cocoons.

d. Young walnut caterpillars on hickory leaf. Natural size.

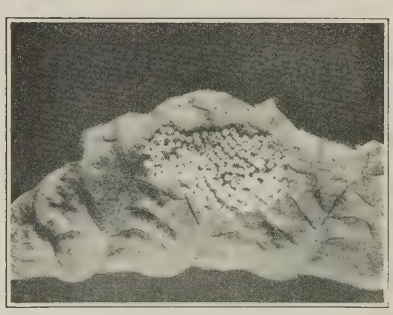
TUSSOCK MOTHS.

a. Adult female. Natural size

b. Mature larva. Natural size.

c. Pupæ. Natural size.

d. Cast skins on tree trunk.



e. Egg-cluster. Natural size.

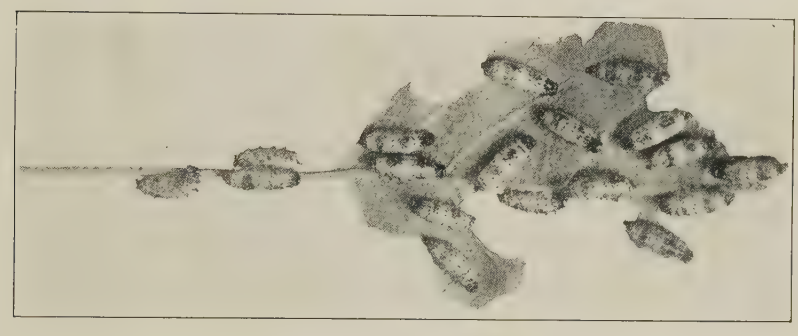
WALNUT CATERPILLAR

a. Adult female and male. Natural size.

b. Caterpillars on apple twigs. Natural size.

YELLOW-NECKED CATERPILLAR.

a. Adult female and male. Natural size.



b. Parasitized caterpillars. Natural size.

c. Mature caterpillar. Enlarged one and one-half times.

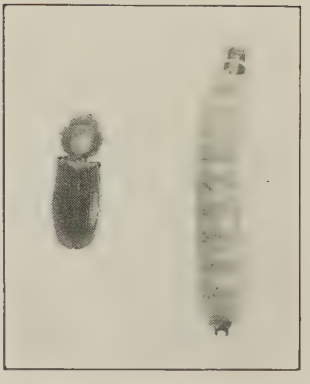
d. Young caterpillars. Natural size.

RED-HUMPED CATERPILLAR.

a. Drug store beetle. Adults. Four times enlarged.

b. Common meal worm, adult and larva. Natural size.

c. Rice weevil. Adults. Four times enlarged.

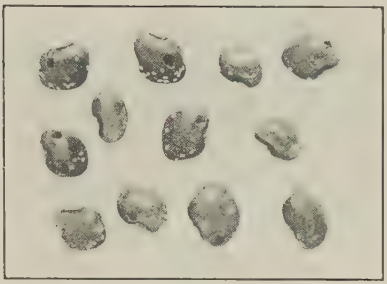


d. Cadelle, adult and larva. Twice natural size.

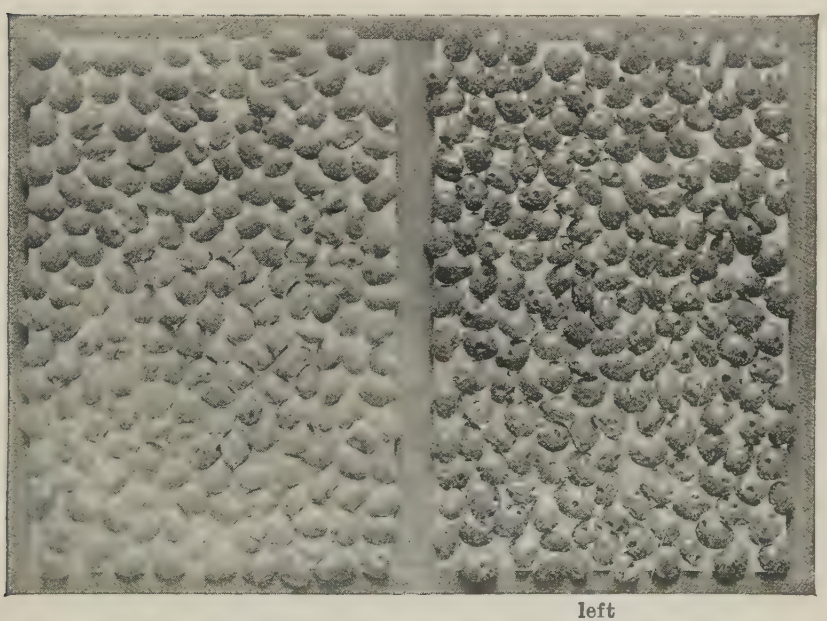
e. Pea weevil, adult beetle. Four times enlarged.

INSECTS ATTACKING STORED FOOD PRODUCTS.

a. Common bean weevil. Adult beetles. Four times enlarged.



b. Infested cow peas, showing eggs and exit holes of bean weevil. Natural size.

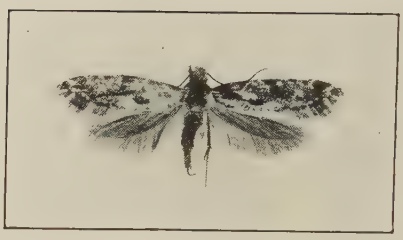


left

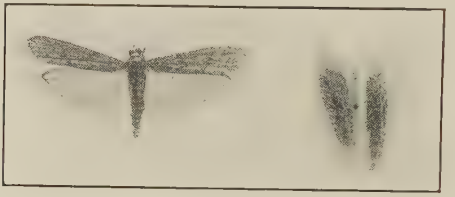
c. Effect of air slaked lime. Treated seeds at [redacted] (After Metcalf, North Carolina Agricultural Experiment Station. Jour. Econ. Ent., Vol. 10, plate 3, fig. 2.)

BEAN WEEVIL.

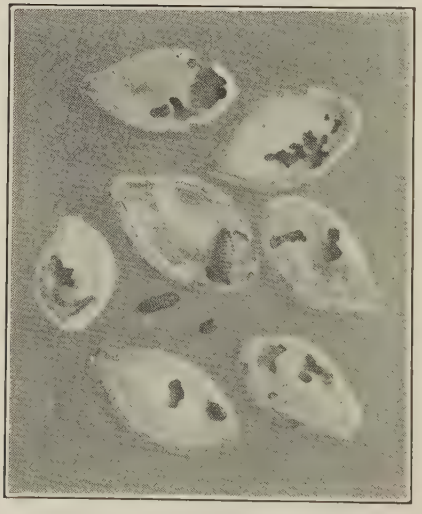
a. Meal snout moth.
Natural size.



b. European grain moth.
Three times enlarged.



c. Mediterranean flour moth and cocoons, slightly enlarged.

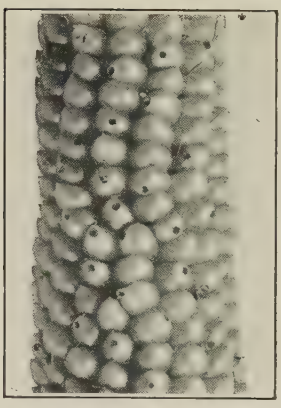


d. Seeds injured by the large cabinet beetle. Natural size.

e. Ear of corn injured by the European grain moth. Half size.

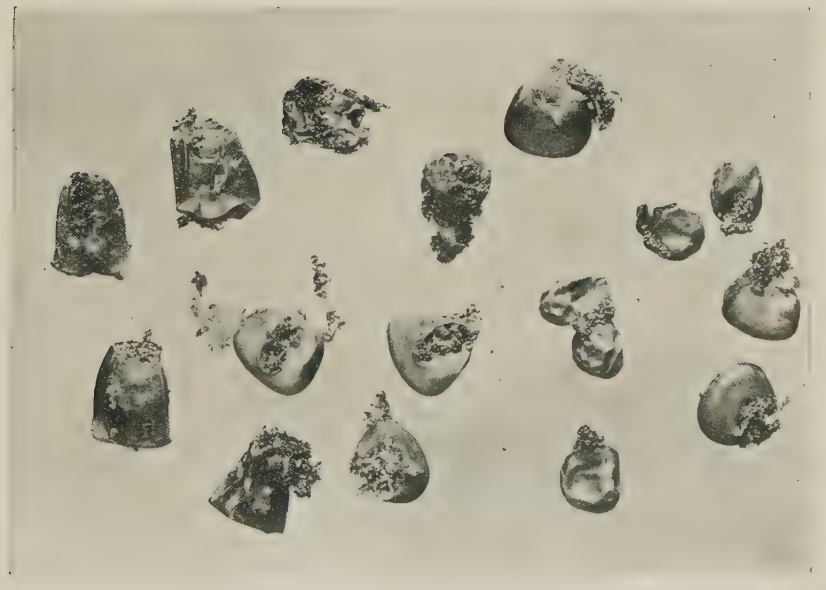
INSECTS INJURING STORED FOOD PRODUCTS.

a. Peruvian seed corn injured by saw-toothed grain beetle. Reduced one-half.



b. Pop corn showing exit holes of Angoumois grain moth. Natural size.

c. Saw-toothed grain beetle. Four times enlarged.



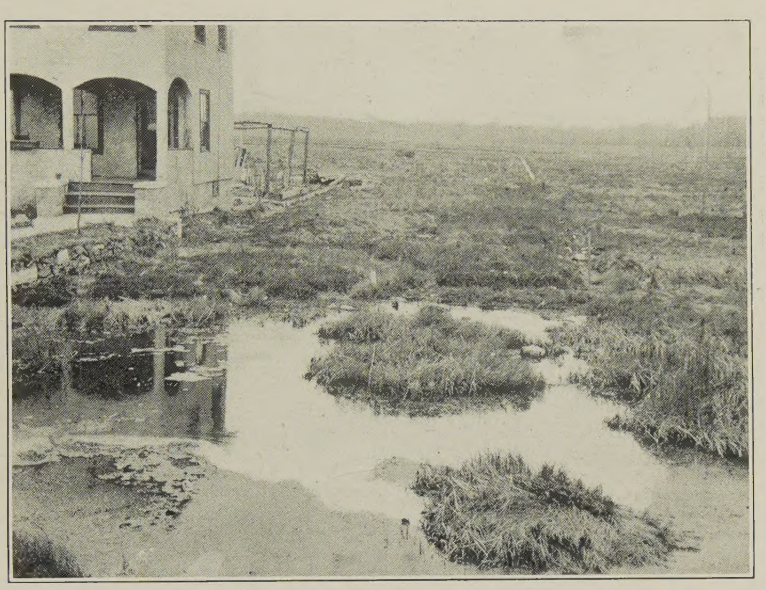
d. Kernels of corn injured by the Indian meal moth. Natural size.

INSECTS INJURING STORED FOOD PRODUCTS.

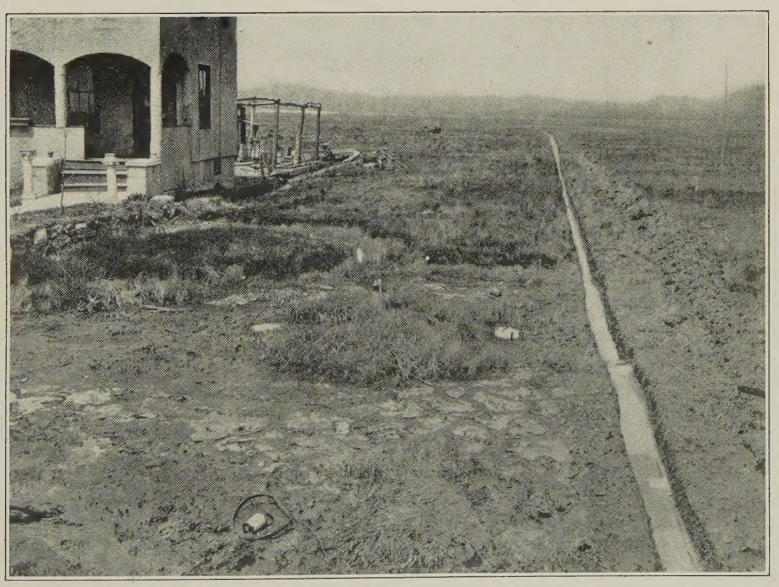
a. View in Quinnipiac Marsh, New Haven, before ditching.

b. Same view, after ditching.

MOSQUITO ELIMINATION WORK.



a. View in Old Field Creek Marsh, West Haven, before ditching.

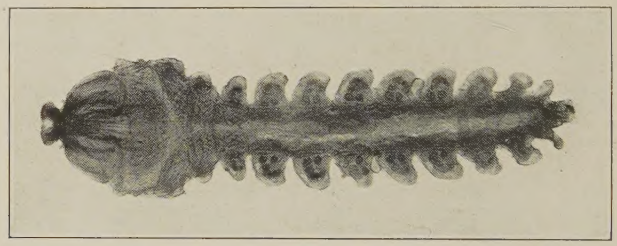


b. Same view, after ditching.

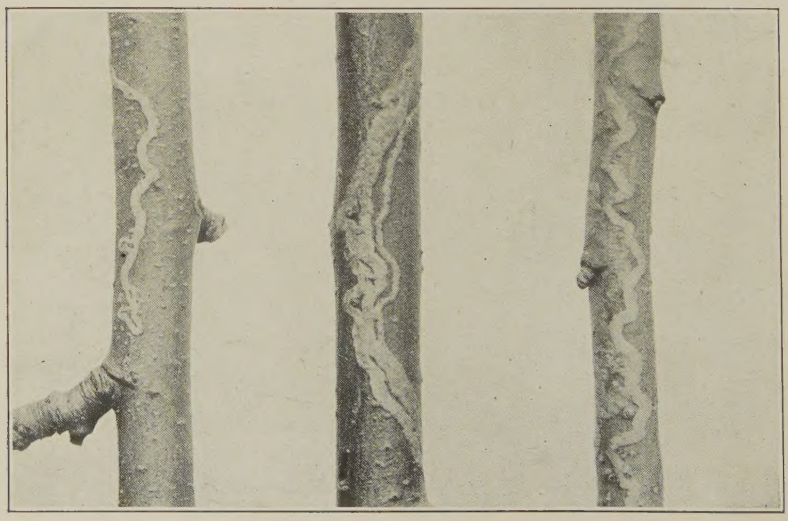
MOSQUITO ELIMINATION WORK.

I. B. E.

a. View in Quinnipiac marsh, showing workmen cleaning old ditch.



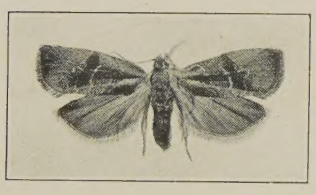
b. Larva of apple twig miner. Enlarged twelve times.



c. Mines in bark of apple twigs. Natural size.

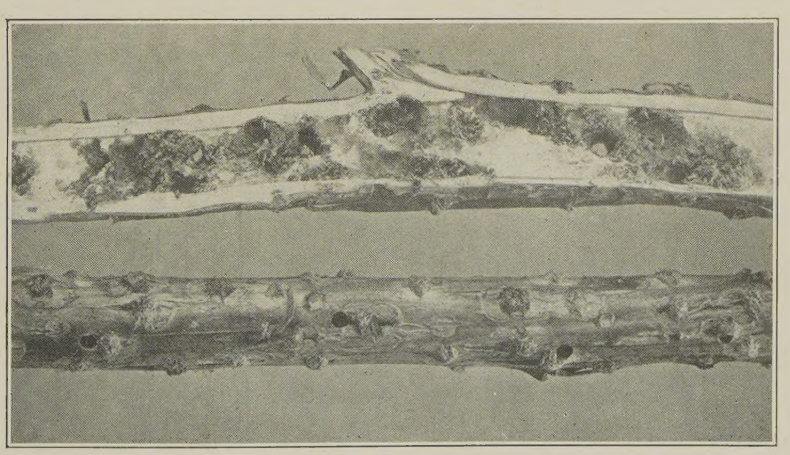
MOSQUITO ELIMINATION WORK AND APPLE TWIG MINER.

a. Larval nests of spiræa leaf roller. Natural size.



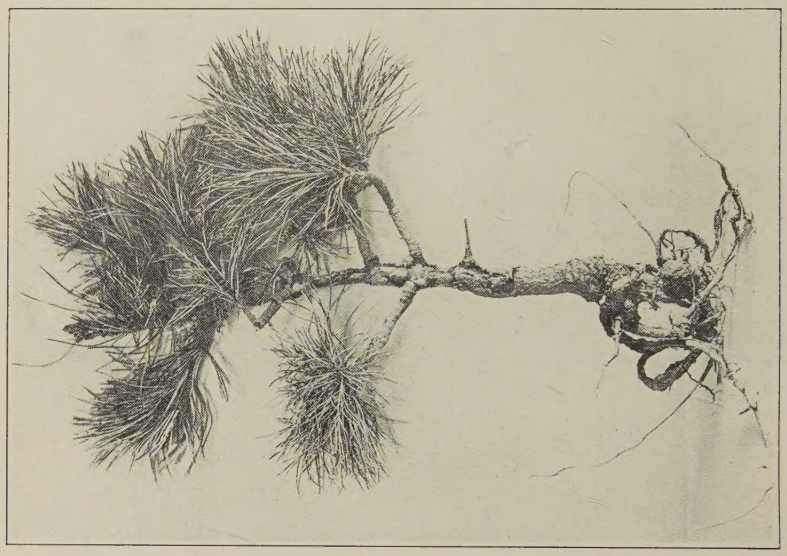
b. Adult of spiræa leaf roller. Twice enlarged.

c. Larger pine weevil. Four times enlarged.

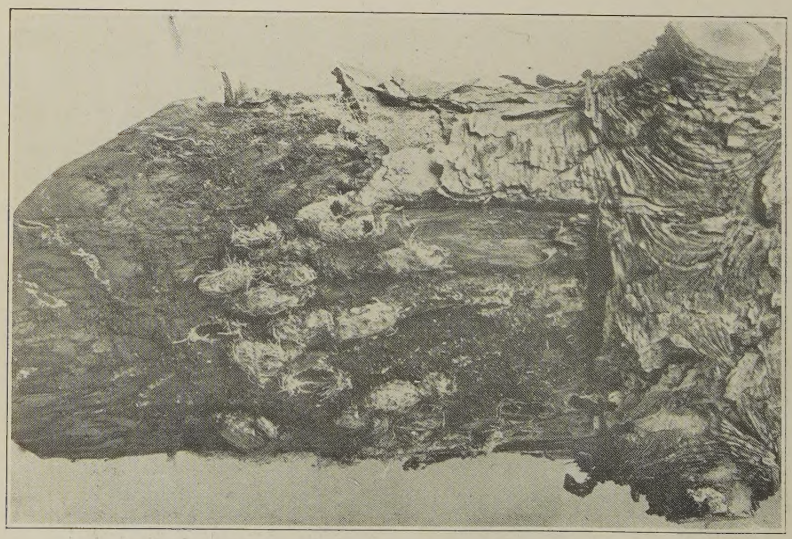


d. Stems of evening primrose tunneled by weevils. Natural size.

SPIRAEA LEAF ROLLER: LARGER PINE WEEVIL: INFESTED STEMS OF EVENING PRIMROSE.



b. Young stone pine, *Pinus cembra*, from nursery, injured by weevils.



a. Pupal cells in trunk of red pine.

WORK OF THE LARGER PINE WEEVIL.